For Editorial Contents see page 371

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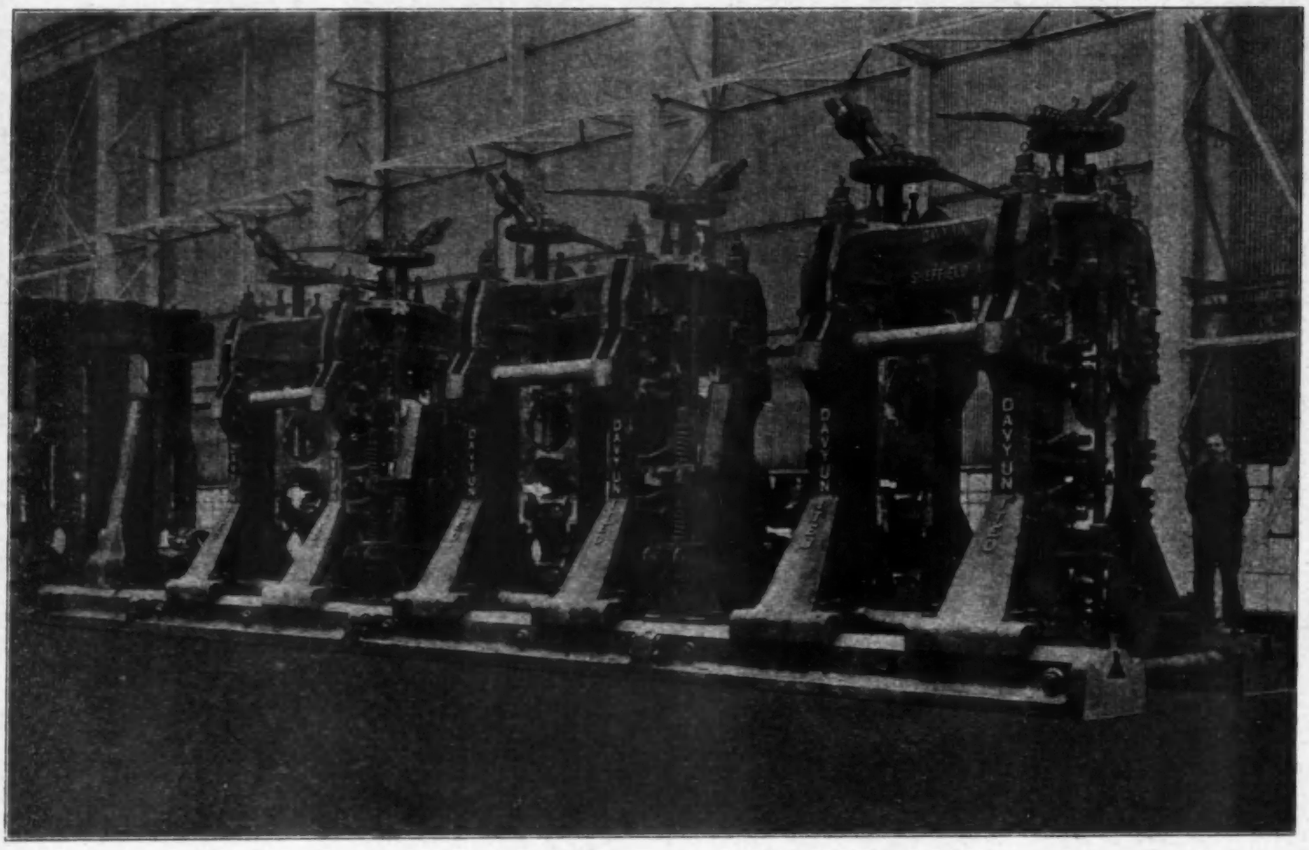

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GRAND COULEE DAM ON THE COLUMBIA RIVER, WASHINGTON, U.S.A.

(*For Description, see Page* 361.)

FIG. 2. COLLECTING CONVEYORS FOR SPOIL.

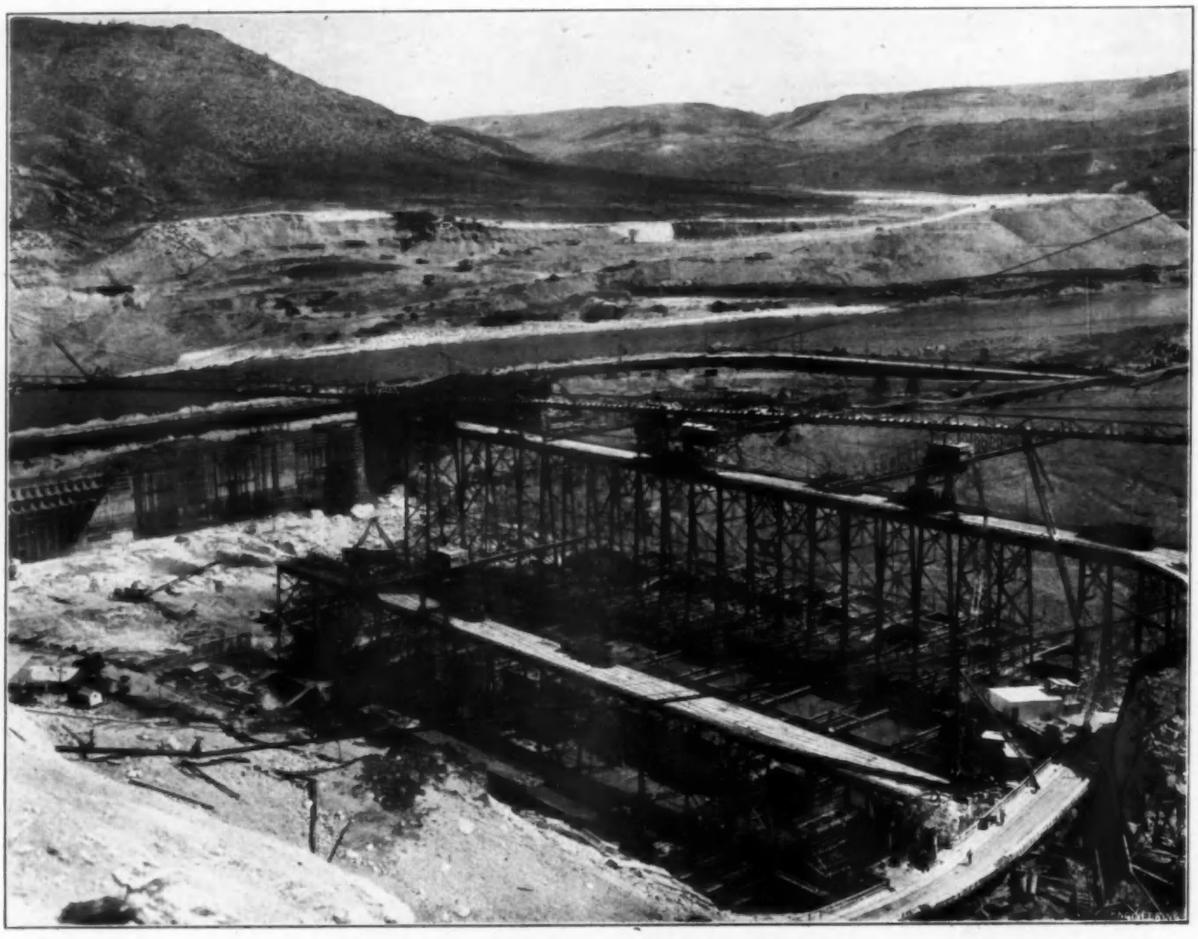


FIG. 3. CONCRETE-DISTRIBUTION TRESTLES SPANNING WORK.

(*To face page* 361.)

UNIV. OF MICH.

THE GRAND COULEE DAM.

As stated in our recent article on the Bonneville Dam, on page 301, *ante*, it was decided, as a result of the survey of the Columbia River, made by the Corps of Engineers of the United States Army, that of the ten dams which were ultimately projected, two should be proceeded with. The survey was completed in 1932, and the two dams are now in commission. That at Bonneville we have already described, and in this and succeeding articles propose to deal with the great structure at Grand Coulee. The Bonneville Dam has features of interest and importance, but as an engineering work it is far surpassed by the Grand Coulee Dam, which in volume is the greatest structure in the world, being, in that respect, three times larger than the next in size. It is situated in the State of Washington, 92 miles west of Spokane and 151 miles, by river, from the Canadian boundary. Its position is shown in the map of the United States' part of the Columbia River, which was given in our first article on the Bonneville Dam and appears on page 302, *ante*.

The Grand Coulee Dam may be described as the key structure of the Columbia River project. As explained in our earlier article, there is a large area in the eastern part of the State of Washington having a comparatively small rainfall. This area lies to the south of Grand Coulee, as shown in the map on page 302, *ante*. The construction of the dam will enable 1,200,000 acres of this land to be irrigated and will at the same time, by regulating the flow of the Columbia River, benefit both power development and navigation farther downstream. Power generation at the dam itself is estimated ultimately to reach 12,510,000,000 kWh annually. This will be produced by eighteen 108,000-kVA main generating units. Three of these are now in operation. They are the largest ever built, the next in size being the 82,500-kW machines at Boulder Dam. Between the Canadian border and tide-water level below the Bonneville Dam, the Columbia River has a total fall of 1,290 ft. Of this, 27 per cent. will be utilised at Grand Coulee.

The 1,200,000 acres which are ultimately to be irrigated lie at an average of 650 ft. above the original river level. The pond formed behind the dam extends to the international boundary, having a length of 151 miles and an average width of 4,000 ft. Its high-water level is 1,292 ft. above sea level. As this is below the level of the land which is to be irrigated, a balancing reservoir has been constructed into which all irrigation water will be pumped. This will raise the level by 280 ft. It is situated to the south of the dam, is 27 miles long and has an area of 27,000 acres. Its maximum capacity is about 1,150,000 acre-feet. The northern earth dam of this reservoir is 2 miles from the Grand Coulee Dam. The pumping plant for filling the reservoir is planned ultimately to consist of ten pumps, each of 16,000 cusecs capacity, against a head of 280 ft. and driven by a 65,000-h.p. synchronous motor. The water for irrigation will be carried through a canal, 10 miles long and of 15,000 cusecs capacity, running in a south-westerly direction and connected to an east-side distribution canal, 150 miles long, and a similar west-side canal, 100 miles long. From these a large number of lateral channels will lead to the farm lands to be supplied. The whole project will include a number of tunnels, siphons, head-gate structures, bridges and drainage channels. There will also be a number of local motor-driven pumping plants, for lifts up to 100 ft., for distributing the water to areas at elevations above the average.

The irrigation of the Columbia River plain forms an important example of the reclamation work now being carried out in many parts of the United States. Some 30 or 40 years ago, the area contained many homesteads and a number of small local irrigation projects were in operation. As stated in the general description of the hydrographical features of the Columbia River, which appeared in our first article on the Bonneville Dam, on page 301, *ante*, the rainfall in this area varies from 6 in. to 14 in. per annum; the average is about 8·2 in. For a number of years, many dry farms were reasonably successful, but long periods of drought, overtaxing of ground-water supplies, and the felling of timber have gradually turned the district into a desolate area, characterised by abandoned farms and small townships. Wheat is still grown in favourable situations, but on the whole the district is one of the areas the conditions of which the present administration of the country is taking such energetic steps to rectify. The soil is a sandy loam of good quality, and it is estimated that the completion of the irrigation project will lead ultimately to the establishment of from 25,000 to 40,000 new farms, with a population of from 100,000 to 200,000 work people. It is naturally realised that a revolution of this kind, especially at first, must develop slowly, and a period of between 25 years and 50 years has been estimated as necessary for the complete reclamation of the region.

As the Grand Coulee Dam is a work of such magnitude and its construction involved so many matters of interest, it will probably facilitate an understanding of the project as a whole if a brief general description of the structure and construction methods is first given, leaving a detailed description to later articles. The dam, a general view of which, showing the downstream side, is given in Fig. 1, on this page, is a straight gravity-type structure. The total length is 4,300 ft. at the crest and 3,000 ft. at the base. The centre 1,650 ft. is occupied by a spillway. On each side of this there will ultimately be a power station, although at present only that at the west end has been constructed. The base of the dam is 500 ft. wide and covers about 30 acres. The width at the crest is 30 ft. From lowest bed-rock to the crown of the roadway which surmounts the dam, is 550 ft. The construction of the dam has raised the water surface 355 ft. above the previous low-water level. The crest of the spillway, which is fitted with 11 drum gates, each 28 ft. high and 135 ft. long, is at elevation 1,260. In addition to the spillway gates for the regulation of river flow, the dam is pierced by 60 outlet conduits, 8 ft. 6 in. in diameter. Twenty of these are at low-water level, twenty 100 ft. above this, and twenty at 200 ft. Each conduit is fitted with two gate valves near the upstream face. In general, river regulation can be controlled by the spillway gates.

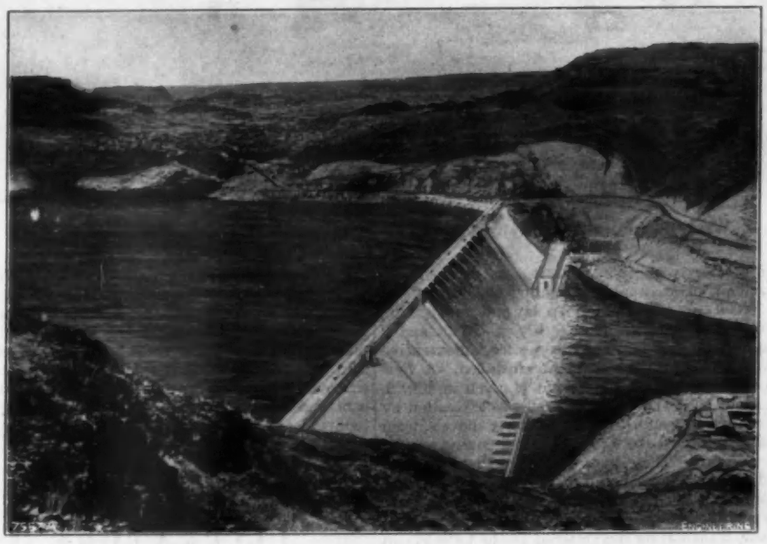


FIG. 1. COMPLETED DAM.

Each of the two power stations will ultimately contain nine 108,000-kVA units, the west station, the one already constructed, containing in addition three 10,000-kW house sets. The generators of the first three main units were built by the Westinghouse Electric and Manufacturing Company, the turbines being supplied by the Newport News Shipbuilding and Drydock Company. Power distribution from this first station commenced on March 22, 1941. The main turbines are of the Francis reaction type, running at 120 r.p.m. They are vertical-shaft machines with runners 16 ft. 5 in. in diameter. The penstocks are 18 ft. in diameter and vary in thickness from $\frac{3}{4}$ in. at their upper ends to $1\frac{1}{4}$ in. at their outlets. They were built in 20-ft. lengths, being welded on site from shaped and planed plates previously prepared. The penstocks for the whole of the final installation of 21 machines have been installed. The main alternators generate three-phase, 60-cycle current at 13,800 volts. This is stepped up to 132,800 volts or 230,000 volts, by banks of three 36,000-kVA transformers of the outdoor type, which are situated behind the power-house building.

The site of the dam was chosen particularly in reference to the irrigation project, which has already been described. The river at the site flows through a canyon some 1,400 ft. deep, 2,000 ft. wide at the bottom and 5,000 ft. wide at the top. At some time in the remote past, the river course was blocked by a glacier and the water, diverted from its natural channel, cut a new bed in the rock plateau. The channel formed is some 52 miles long, 600 ft. to 800 ft. deep, and ranges in width from 2 miles to 5 miles. Ultimately, as the glacier receded, the river returned to its old channel, leaving the newly formed course high and dry, with its bottom about 600 ft. above the ordinary water level of the river. This, now abandoned, channel is the Grand Coulee. It lies to the south of the dam site and has been utilised to form the balancing reservoir for the irrigation project, its ends being closed by earth and rock-fill dams. It is supplied by pumping, as already mentioned.

The bedrock at the site of the Grand Coulee Dam, consists of granite which extends across the river at about elevation 870. It rises on each side, with slopes of 2 in 1, to form the canyon walls. The overburden was 40 ft. thick in the centre of the river and as much as 200 ft. at the toes of the side slopes, where successive slides over long periods had piled great masses of material. The removal and disposal of this overburden constituted one of the main constructional problems. The land which has been inundated by the filling of the pond behind the dam, consisted mainly of grazing areas and timber lands, which had already been cleared, so that, in view of the magnitude of the project, the amount of damage caused upstream is comparatively small. As originally projected in 1933, the Grand Coulee Dam was to consist of a structure only 300 ft. high, with a length of 3,400 ft. at the crest, and a permanent cofferdam downstream. This latter was to be located below the toe of the low dam and was to form the toe of a future high dam. The low dam would have provided for an initial power

THE GRAND COULEE DAM ON THE COLUMBIA RIVER, WASHINGTON, U.S.A.

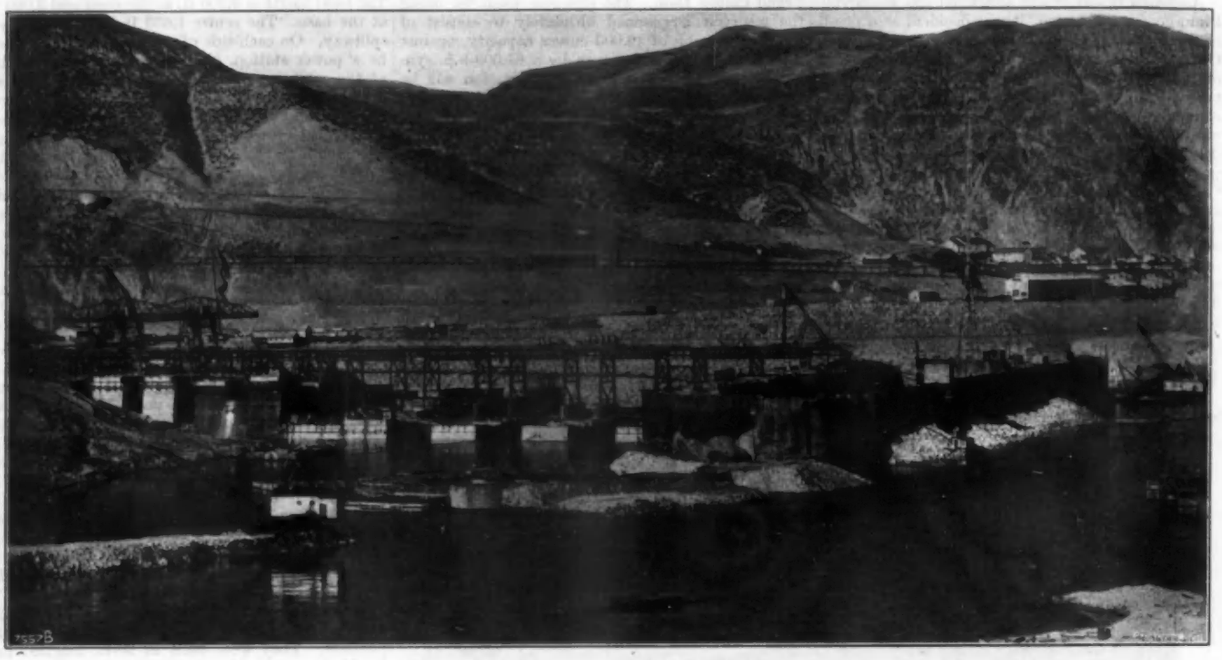


FIG. 4. WEST-SIDE COFFERDAM PARTLY DISMANTLED.

development of 520,000 kVA. When excavation for the foundations of the low dam had been in progress for several months, however, extensive slides took place from the canyon walls above. In view of this, and of the consideration that the ultimate construction of the high dam by raising the low dam might have caused difficulties at the joint between the new and old work, it was decided, in 1935, that the high dam should be proceeded with.

The dam was constructed by unwatering the two ends of the site behind cofferdams, the bases of which were located at approximately low-water contour on each side of the river. Excavation was carried out to bedrock in these areas and the two ends of the dam constructed, leaving the main river channel for final closure. This last operation was carried out by diverting the water through a 350-ft. section of the spillway, adjacent to the west power house, additional channels for the escape of the water being provided by narrow gaps which had been left in the power-house structures. In view of the great elevation of the river surface above bedrock at high water, amounting to 110 ft., and of the instability of the 70-ft. average depth of overburden which had to be removed from the site, it was decided to use sheet-pile cellular cofferdams of the type which were described in our recent article on the Pickwick Landing Dam.* As an additional precaution against water attack below the cofferdam cells, a substantial berme of overburden material was left inside the cofferdam during high-water season. Part of one of the cellular cofferdams is illustrated in Fig. 4, on this page. The view is taken from the east bank and shows the west cofferdam at a stage when part of its upstream face has been removed to allow the river to flow through the gaps in the west foundation.

As already mentioned, one of the major operations which had to be undertaken in the construction of the dam was the removal of overburden. More than 10,000,000 cub. yds. of material was excavated from within the west cofferdam alone and transported to a spoil bank in Rattlesnake Canyon, 6,000 ft. away. This canyon is about 250 ft. deep, nearly a mile wide and several miles long. Similar operations had to be carried out on the east side. For dealing with this work it was necessary to provide a plant capable of loading 40,000 cub. yd. to 50,000 cub. yd. of material a day and transporting it 6,000 ft., with an average lift of 425 ft. and a maximum of 595 ft. For this service, an extensive 60-in. belt conveyor system was installed. A view showing part of the equipment is given in Fig. 2, on Plate XXVIII. The material was excavated by 2-cub. yd. to 5-cub. yd. electric power shovels, from which 12 cub. yd. to 20 cub. yd. side-dumping wagons were loaded. These were drawn by Diesel tractors and delivered to tributary conveyors, which, in turn, delivered the material to the main 60-in. conveyor. Two of the tributary conveyors and the main conveyor, transporting the material up the hillside, can be seen in Fig. 2.

The total amount of concrete laid in the construction of the dam was about 11,000,000 cub. yd. In the earlier stages this was supplied from two plants, one on each side of the river, but later they were combined into a single plant on the east side. The highest rate of placement was reached in October, 1939, when an average of 17,299 cub. yd. of concrete were placed per day. The concrete was distributed to the work by means of high steel trestles built across the site. Two of these trestles can be seen in Fig. 3, on Plate XXVIII, which shows work in progress on the west side. The lower trestle in this figure was situated below the position of the downstream face of the dam and was used for the delivery of concrete to the lower part of the structure. The higher, on the centre line, was used for completing the work. Concrete was delivered to the trestles in 4-yd. buckets, carried on flat cars drawn by Diesel-electric locomotives. The buckets were lifted from the cars and transported to their dumping position by slewing jib cranes and transporter cranes. Both of these types can be seen in Fig. 3.

In view of the enormous amount of material required, it was fortunate that a large deposit of suitable aggregate was found at a point about a mile and a half north of the last abutment of the dam. This material consisted of glacier-deposited sand and gravel, and was located 900 ft. above the river and 400 ft. above a suitable site for the preparation plant. Two 42-in. conveyors, carried on pivoted radial booms, 200 ft. long, were erected in the gravel pit. These delivered to a 60-in. main conveyor, which fed a stock pile alongside the preparation plant, consisting of screens and crushers. The aggregates were then delivered to the concrete-mixing plant by further 42-in. conveyors, one of which, 2,157 ft. long, is thought to be the longest of its size ever built. Cement was brought by rail in box cars and was delivered to the plant by cement pumps. On some days the cement consumption reached 100 car loads.

(To be continued.)

* See page 301, *ante*.

LITERATURE.

Reinforced Concrete Chimneys. By C. PERCY TAYLOR, F.C.G.I., M.Inst.C.E., and LESLIE TURNER, B.Sc., M.Inst.C.E. London: Concrete Publications, Limited. [Price 8s. 6d. net.]

THE brick factory chimney dates from the earliest days of the industrial era, and the steel chimney has been in use for several generations. For both types, design methods have been largely empirical. Reinforced concrete is a development of the present century; the authors of this book give 30 years as the present limit of age of British concrete chimneys. The modern design of reinforced-concrete chimneys involves closer study of strength and stress distribution than does that of the older forms. The authors, whose combined experience covers practically the whole period of concrete chimney construction, have limited themselves strictly to structural design. Even so, their introductory chapter, which illustrates with drawings a few chimneys that have been built in this country, might have been enlarged with advantage to give examples of work abroad; particularly in America, where concrete chimneys of outstanding dimensions have been built.

The fundamentals of chimney design are weight, wind pressure and temperature effects. Consideration is given to the first two, and it is pointed out that, as the accepted theory of reinforced-concrete design assumes the concrete to take no tension in bending, whereas under direct compression the whole of the concrete is stressed, weight and wind pressure cannot be considered separately in stress

calculations. Exact data on distribution of wind pressure is limited. Much of it, such as the results of experiments on plates of various forms, cannot be applied with certainty; neither can meteorological investigations of wind structure be adopted in their entirety. Direct observations on existing chimneys are a much more valuable guide but, unfortunately, are few; many more experiments could be made with benefit to design. The authors have collated the recent work of British and American investigators and have arrived at a formula which, in conjunction with the Meteorological Office formula for variation of velocity with height, enables them to give a chart of pressures applicable to design.

The determination of the combined stresses is treated fully and clearly and the rather cumbersome formulæ are reduced to a series of charts, reproduced on folding plates at the end of the volume. As at this stage temperature stresses have not been considered, working stresses are limited to between 400 lb. and 500 lb. per square inch compression on the concrete and 1,500 lb. and 5,000 lb. per square inch on the steel, leaving a working margin to provide for heat stresses. A short chapter deals with recent investigations of the temperature drop between the inner face of the lining and the outer face of the shell. Again, published information is not plentiful. By supplementing it by their own observations, the authors have devised a formula for calculating this drop from that between the gases and the outer air. Chapter IV gives the evolution of a theory, applied to the different stress conditions, by which the effect of temperature drop on stresses is calculable. The theory is founded on the normal premises, using the stresses previously determined as a basis, and enables the position of the neutral surface in the section of the shell to be determined, and hence the maximum stresses due to all the combined causes to be calculated.

The concluding chapter gives some practical details on foundations, linings, cappings, etc. It is disappointing to find that foundations are dismissed with only a page of general maxims; the foundation of a monolithic chimney is as integral a part of the whole as is the shell, and much new work has been done on foundations which might be applied to this subject. In general, however, it may be said that this book sets out fully and clearly the details of a practical method of design. It is the first British book to deal exclusively with the subject, and must prove of value to engineers who may be brought into contact with reinforced-concrete chimney design and kindred structural problems.

The Suspended Matter in the Nile. Report on Investigations Relating to Aswan Reservoir. By Y. M. Simaika, Ministry of Public Works, Egypt. Cairo: Schindler's Press. [Price 4s.]

It was a commonplace, even among the ancients, that Egypt was the creation of the Nile mud, and many studies have been made in the past of the quantities flowing down the river and the accretion due to their deposit. It is generally accepted that the alluvial plain rises some 9 cm. per century, due to the silt deposited thereon, and it is known that the quantity per annum which passes down at the First Cataract is of the order of 100 million tons. The Aswan Dam is provided with low-level sluices for the easy removal of silt behind it and is generally fully open during the strong flood period, so that questions of silting up of the reservoir have not hitherto been of great significance. The heightening of the dam and the possibilities of its utilisation for storage during exceptional floods have made the question of silting more important, and it was the special purpose of this inquiry to discover how much silt would be deposited by storing flood water in the reservoir.

The work was commenced by the late Dr. R. Phillips, Director of the Hydrological Service of the Physical Department, and has been continued and presented by his successor, Yusef M. Simaika Bey. The observations were taken at Wadi Halfa, Khannaq (Gaafra), Dekka and Aswan from 1929 to 1938, at a large number of points well distributed over the entire cross-section of the river, and at least three times weekly during the flood season. Thus, in 1929, at Wadi Halfa, over 150 miles above the dam, and at Gaafra, some 20 miles below the dam, samples were collected daily from 24 points taken at three depths on each of eight verticals. The three depths were at 50 cm. below the surface, at mid-depth and 50 cm. above the bottom.

The silt contents were measured in parts per million by weight, and were separated by a sedimentation process into sand, silt and clay fractions, the critical effective spherical diameters being 0·02 and 0·002 mm., respectively. Distribution with depth, width and place are studied carefully in the report. The relation to stage is also indicated, but, rather curiously, no relation to mean velocity is given, although this could have been easily computed. As might have been expected, the percentage of sand increases with the flood. The concentration varies from about 50 parts per million by weight to a maximum of about 4,000. These figures resemble those found in the Yangtze by the Whangpoo Conservancy Board and the Yangtze River Commission.

Considerable attention is given to the question of the relation between the weight of the silt and its volume when settled. There is a serious omission here in the absence of all reference to the consolidation experiments of Terzaghi and his school. Dried samples of mud from various places were found to vary from 0·6 gramme to 1·27 grammes weight per cubic centimetre of the wet mud, indicating that the pore coefficient varies from 3·0 down to 1·0. A further investigation of the form of the particles and in the oedometer would enable the problem of volume of mud per ton of settled silt to be settled fairly definitely. The old problem of "bed-load" is discussed without any final conclusion, but some interesting facts are indicated.

On the main problem, it is shown that, up to the present, the quantities of suspended matter deposited (as apart from matter rolled along the bed) have produced negligible effect on the volume of the reservoir. In 1938, when the level was kept high from August 21 to November 16, of 118 million tons that passed Wadi Halfa, 23 million tons were deposited in the reservoir. The capacity of the reservoir at reduced level of 110 m. is about 1,000 million cub. m. This storage would reduce the stage at Cairo by about half a metre. Reckoning very roughly a ton of silt as forming a cubic metre of mud, these figures seem to show that an annual repetition of the 1938 experiment would fill the reservoir in some 40 years. It is clear that such a practice could not be adopted very frequently, and the author wisely advocates much further observation, including echo-sounding in the reservoir itself.

Dr. John Ball, in his *Contributions to the Geography of Egypt* (Cairo, 1939), has summarised the previous information on the silt-carrying capacity of the Nile, and it would seem very desirable that all the data should be co-ordinated and brought into a complete document. The precedents set in the Yangtze and Mississippi might well be followed, since the Nile is the prime example of the importance of siltation, and, owing to the dam and barrages, presents unexampled opportunities for measurement. One aspect of this subject that the Egyptian authorities do not seem to have tackled is the consolidation of the alluvial plain. The methods of soil mechanics have shown how the self-consolidation of alluvium can be measured, and it is quite possible that the 9 cm. per century includes a consolidation factor of some importance. The subsidence, if any, of the rock substratum, whether by reason of the silt deposit or on account of deep-seated movements, will enter into the problem.

The author makes a passing reference to the recent work on turbulence in relation to silt suspension, and also endorses the late Dr. Phillips' very remarkable formula for flow in the Nile, V=CRS, with, however, the remark that Dr. Hurst's investigations show that it is impossible to fit formulæ to natural channels. In view of Gerald Lacey's work in India, this seems rather an extreme statement. This little book can be strongly recommended to all engineers and geographers interested in river problems.

Society of Chemical Industry.—The Medal for 1941 of the Society of Chemical Industry will be awarded to Sir Robert Pickard, F.R.S., at the annual general meeting of the Society, to be held in London on July 8.

EFFECTS OF THE WAR UPON SOUTH AMERICAN MARKETS.

The adverse effects of European hostilities upon South America's economy are now becoming more clearly defined. During the first months of 1940, South American export trade was fairly buoyant, and the steep decline did not commence until the early summer of last year, when one European market after another was lost through the overrunning of so many countries by the Germans, the entry of Italy into the war, and the extension of hostilities to the Mediterranean, thereby subjecting almost the entire European Continent to the British sea blockade. While, therefore, the trade returns for 1940 of the principal republics do not fully reflect the sharp decline in exports over recent months, they are sufficiently disconcerting, particularly as they confirm that a considerable proportion of exportable surpluses of primary products is virtually frozen. In normal times, the European Continent, not including Great Britain, absorbed some 30 per cent. to 40 per cent. of exports from the principal South American countries, but, in the later months of 1940, shipments to Europe dwindled to very low levels. Therefore, continuation of the present European situation would render the economic outlook in South America increasingly uncertain, and prognostications of future developments are impossible pending some clarification of the fortunes of war and the resultant fluctuations of overseas demand for primary products, as well as supplies of available export tonnage.

The present loss of European markets for primary products means, of course, reduced income to South America, and a consequent contraction in its purchasing power. This factor, combined with the difficulties of obtaining manufactured articles from Europe because of the blockade and the shortage of shipping, has already led to two main developments in South American trade: firstly, a powerful impetus to the national manufacturing industries, such as occurred after the Great War of 1914-18, and, secondly, intensification of inter-American trade, particularly with the United States. Increased industrialisation is likely to be reflected in larger purchases by South America of semi-manufactured articles and raw materials, and relatively smaller purchases of finished manufactured articles (such as machinery and vehicles, iron and steel manufactures, etc.), and it is fair to assume that, the longer the war lasts, the more accentuated will this tendency become—at least, as regards imports from Europe. On the other hand, the enormous credits which the United States intends to grant to South American countries through the Export-Import Bank of Washington have direct relation to the development of local industries, inasmuch as they will be used partly to capitalise transport undertakings and to foster industrial projects, particularly in the larger and more developed countries, such as Argentina and Brazil. Illustrating the growth of inter-American trade, official figures issued in New York show that the total value of exports from the United States to Latin America in the calendar year 1940 jumped to 727,000,000 dols., from 569,000,000 dols. in 1939. Nevertheless, notwithstanding present difficulties, it would appear essential that Great Britain should already be working out a long-term policy in regard to commerce with South America, so as to pave the way for the resumption of mutually profitable trade when the hampering conditions of war have been removed; particularly as European markets, and especially Great Britain, will always be an essential outlet for products from South America. Taking the long view, South America has vast undeveloped potentialities which should necessitate large imports of transport material, heavy machinery, etc., for many years to come. Meanwhile, the Willingdon Mission has returned to London from South America, and is expected to make recommendations on many subjects with regard to their value to British trade both during and after the present war.

Argentina's chief problem continues to be the lack of foreign markets for grain, bought from the farmers at fixed prices by the Government, which

may thereby incur considerable loss. The coming maize harvest is expected to be very large, but this brings no consolation while the problem of marketing remains unsolved. Over the complete year 1940, Argentina registered an adverse trade balance of 70,824,000 pesos, whereas a surplus of some 450,000,000 pesos is generally calculated to be needed each year to equilibrate international payments. During the first two months of 1941, a favourable trade balance of some 49,500,000 pesos was re-established, but this is poor consolation for the fact that, compared with the like period of 1940, total imports fell in value by 52·5 per cent. and exports by 46 per cent. Actually, the combined value of imports and exports in February was the lowest recorded since the last war. The United States has already granted Argentina credits totalling 110,000,000 dols. to support the currency in face of the adverse trade movement, and to finance the export of transport, engineering and other capital goods to Argentina. Over the full year 1940, North American goods represented 29·1 per cent. of Argentina's total imports (against 17·2 per cent. in 1939); those from the United Kingdom, 19·8 per cent. (19·9); and those from Brazil, 7·9 per cent. (6·5). During the first two months of 1941, imports from the United States represented 23·6 per cent. of total imports (against 27·1 per cent. in the corresponding period of 1940); from the United Kingdom, 18·7 per cent. (20·9); while those from Brazil jumped to 13·7 per cent. (against 4·3 per cent.). Illustrating Argentina's increasing trade connections with the United States, it is understood that the Buenos Aires Transport Corporation has placed an order in North America for 54 motor-omnibuses to replace the *colectivos* in the local transport services. It is further understood that the Corporation has been authorised to buy 200 omnibuses and that typical vehicles are at present undergoing trials on suburban routes.

As will be seen from the following official statistics, there was a decided decline in Argentina's imports of engineering and allied products in 1940, compared with those in 1939, which are given in parentheses :—Fuel and lubricants, 3,999,000 metric tons (5,031,000) with a tariff value of 188,601,000 pesos (231,299,000); machinery and vehicles, 129,000 tons (157,000) value 107,061,000 pesos (131,714,000); iron and steel manufactures, 569,000 tons (693,000) value 99,330,000 pesos (121,824,000); other metals and manufactures, 128,000 tons (110,000) value 64,235,000 pesos (64,354,000). This sharp downward tendency was even more observable during the first two months of 1941, amounting to about 70 per cent. in the case of machinery and vehicles, as well as iron and steel and manufactures thereof. The imports for those two months were as follows, the comparable figures for the similar period of 1940 being given in parentheses :—Fuel and lubricants, 466,231 metric tons (711,232) with a tariff value of 22,312,539 pesos (29,943,664); machinery and vehicles, only 9,922 tons (34,502) value 8,013,314 pesos (26,370,950); iron and steel and manufactures, 35,184 tons (131,064), value 5,834,586 pesos (21,151,560); and other metals and manufactures, 13,463 tons (28,982), value 6,808,116 pesos (13,216,339). Meanwhile, however, the Argentine Government has passed a decree approving the public works programme for 1941, and authorising the expenditure of 197,264,000 pesos (say, 12,000,000*l.* sterling) in this connection. The total amount similarly authorised for 1940 was 171,000,000 pesos. The expenditure authorised for the current year does not provide for any new undertakings, the principal allocations being as follows :—Sanitation, 57,690,000 pesos; War and Marine Departments, 35,108,000 pesos; State Railways, 25,400,000 pesos; architecture, 23,638,000 pesos; navigation and ports, 22,316,000 pesos; and irrigation, 16,014,000 pesos.

Following the recent resignation of Dr. Pinedo, Argentine Minister of Finance, it is doubtful whether the comprehensive economic reorganisation plan recently presented by him will be proceeded with, particularly in view of the obscure political and economic situation. This plan provided, *inter alia*, for the repatriation of Argentine Government loans and the purchase of other sterling securities, including the British-owned railways. The Argentine Government is endeavouring to dispose of the enormous surplus of maize within the country by such means as using it as railway fuel; following recent experiments, it is officially stated that a mixture of uncobbed maize and coal can be used effectively for goods traffic, the proportion of maize varying from 40 per cent. in the case of fast trains up to 60 per cent. for slow stopping trains. In present circumstances, therefore, it seems unlikely that the Argentine Government will grant the concession long sought by the railways, for increases in freight rates so as to bring revenue more into line with expenditure. Nevertheless, at the end of March, the railways—mainly British-owned—reiterated their request, revealing that their net receipts aggregated only 26,000,000 pesos in 1940, whereas interest on debentures alone requires some 56,400,000 pesos per annum at par, or 79,000,000 pesos at the special rate established for railway remittances. The note pointed out that the shareholders had no hope whatever of receiving any dividends under present conditions, and, in fact, had received none for several years. At present, the funds available for renewals were restricted to such an extent as to impair the efficiency of the services. Finally, the companies requested that measures be taken to place the railways on a sound economic footing, with equitable treatment in relation to other forms of transport, stressing the fact that they were absolutely indispensable, and irreplaceable, except as regards medium freights, by lorry transport.

In the neighbouring River Plate country of Uruguay, the general position is relatively buoyant because of good sales of wool, the chief export product, particularly to the United States. Imports include general machinery, motor cars and accessories, and electrical material, while important lines are coal, oil and lubricants. Early in 1937, as mentioned in a previous article, a contract was entered into with Germany for the harnessing of the Rio Negro, which would supply electric power throughout Uruguay. It is now reported that the Uruguayan authorities do not intend to make any further representations to the British Government for the machinery to be shipped from Germany to Montevideo. The report further states that, as neither British nor American firms will undertake to manufacture similar machinery in the required time, the scheme is to be suspended until after the war, once the constructional work is finished, which should be in December next.

The quota arrangements for imports of coffee into the United States—practically the only remaining world coffee market left open—from Brazil, Colombia and the Central American republics, is working smoothly, while much benefit is being derived from the steep rise in coffee prices. Nevertheless, due mainly to the reduced shipments of coffee and cotton in 1940, Brazil's exports declined in value by 14·2 per cent., while imports fell by 4·3 per cent. The outstanding effect of the war on Brazil's overseas trade is the sharp fall in imports from Europe and a corresponding expansion of about 50 per cent. in imports from the United States in 1940 compared with 1939. Imports of machinery and allied lines during 1940 (values in £'s gold) from all sources compare as follows with those of 1939, given in parentheses :—Machinery, tools, etc., 43,000 tons (63,000) value 4,576,000*l.* (6,307,000*l.*); iron and steel manufactures, 198,000 tons (237,000) value 2,722,000*l.* (2,830,000*l.*); motor cars, lorries and chassis, 23,500 units (21,700) value 1,918,000*l.* (1,827,000*l.*); other vehicles and accessories, 25,600 tons (22,500) value 1,339,000*l.* (1,505,000*l.*); raw iron and steel, 96,000 tons (91,000) value 1,086,000*l.* (845,000*l.*); coal, coke and patent fuel, 1,209,000 tons (1,382,000) value 1,671,000*l.* (1,484,000*l.*); petrol, 368,000 tons (370,000) value 1,216,000*l.* (1,071,000*l.*); fuel and Diesel oil, 694,000 tons (724,000) value 1,049,000*l.* (795,000*l.*); lubricating oils, 44,000 tons (44,000) value 416,000*l.* (413,000*l.*); kerosene, 102,000 tons (95,000) value 302,000*l.* (253,000*l.*); pneumatic tyres, 2,900 tons (4,200) value 243,000*l.* (344,000*l.*).

Final arrangements have now been made for the establishment of the national steel plant—referred to on page 264, *ante*—the site for which, at Volta Redonda, ensures easy access to iron ore from the State of Minas Geraes and to coal supplies through the port of Rio de Janeiro, while being conveniently situated between the cities of Rio de Janeiro and São Paulo, which will be the largest markets for the products of the works. Brazil's production of steel in 1940 rose to 141,076 tons, with a value of 113,174 contos, from 114,095 tons in 1939, valued at 90,169 contos. (One conto = 12*l.* 10*s.*) A Five-Year Development Plan was inaugurated in January, 1939, involving the outlay of 3,000,000 contos (about 37,500,000*l.* sterling), and expenditure under this plan during 1941 includes 130,000 contos on transport and public works and a further 50,000 contos for national siderurgy. Recent engineering contracts placed in the United States include that for the electrification of the Sorocabana Railway at a total cost, including interest charges, of some 180,000 contos, payable over 12 years. It is claimed that the annual economy to the railway effected by the change-over to electric traction will be some 24,000 contos. Among other developments, the city of Rio de Janeiro has adopted an extensive programme of public works and improvements, to cost 1,000,000 contos.

In Chile, there appears little possibility of relief to the general stringency in sterling to pay for British goods unless, reciprocally, Britain purchases Chilean agricultural products, and negotiations are said to be proceeding in this direction. Meanwhile, the latest trade returns, covering the first ten months of 1940, show that Chile's imports from the United States rose to 188,600,000 pesos of 6*d.* gold, from 100,200,000 pesos in the corresponding period of 1939; but those from Britain were worth only 39,000,000 pesos, against 29,100,000 pesos. Imports during the ten months of last year compare as follows with those in the similar period of 1939, given in parentheses :—Chemicals, oils, paints, etc., 57,161,200 pesos (43,877,700); iron, steel and other metals, and manufactures, 52,259,700 pesos (44,472,000); machinery, tools, electrical materials, etc., 44,979,200 pesos (47,957,900); transport material, 36,448,400 pesos (35,019,300); crude petroleum and Diesel oil, 25,687,700 pesos (16,296,700); scientific instruments, 11,548,000 pesos (11,426,600); and coal and coke, 10,379,800 pesos (563,500).

Some relief to the sterling position in Peru has been afforded by British Government purchases of cotton. Here again, however, the imports from the United States increased from 41·1 per cent. of total imports in 1939 to 53·1 per cent. in 1940, while those from Britain were only 9·2 per cent., against 8·4 per cent. Imports from all sources of engineering and allied products in 1940 compare as follows with those for 1939 :—Machinery and vehicles, 64,716,000 soles (49,627,000); metals and manufactures, 39,984,000 soles (32,702,000); chemical and pharmaceutical products, 24,824,000 soles (20,460,000); paints, oils, etc., 23,368,000 soles (16,548,000); electrical material, 12,399,000 soles (9,789,000); timber and manufactures, 11,818,000 soles (8,935,000). The fixed sterling rate of exchange for payments through Special Account is 26·16 soles per £.

MINER'S WELFARE NATIONAL SCHOLARSHIP SCHEME.—The Trustees of the Miners' Welfare National Scholarship Scheme, established by the Miners' Welfare Commission for the provision of University scholarships for workers in or about coal mines and their sons and daughters, have appointed Mr. Tom Smith, M.P., and Miss J. R. Bacon, M.A., to be members of the Selection Committee to recommend awards under the scheme. Mr. Smith and Miss Bacon succeed Mr. J. J. Lawson, M.P., and Miss E. H. Major, C.B.E., M.A., who have retired, in accordance with the Trust Deed, after completing five years on the Committee.

BRITISH DOMINIONS AND AMERICAN STANDARDS.—In present circumstances, even more than is the case in normal times, it is important that manufacturers in the United Kingdom should be familiar with the industrial standards adopted in the Dominions and in the United States, just as it is that engineers in those countries should be familiar with British Standards. In this connection, we are requested to remind our readers that the standards issued by the official standardising bodies in the Dominions and in the United States are regularly received by the British Standards Institution, in London, and that copies can be obtained on application to the Director, at 28, Victoria-street, London, S.W.1.

WELDED ROOF TRUSSES.

An interesting comparison between roof trusses constructed by welding or by riveting and bolting may be made from the data given below on the construction and erection of a number of arc-welded roof trusses by Messrs. Douglas, Lawson and Company, Limited, Gelderd-road, Birstall, near Leeds. This firm, having found it necessary to extend its works, and the new shop not requiring head-room above the level of the wall-plate, decided that a trussed roof should be adopted, especially as the lightest possible weight of steel was a primary consideration. The firm had facilities for constructing the trusses either by riveting or by welding, so that the choice of the method to be employed was made solely from a consideration of costs and weights. Careful drawings and calculations were made of the trusses as constructed by both methods, and on the information thus obtained it was decided to proceed with welded trusses.

The trusses have a span of 48 ft. and a rise of 12 ft., the slope being thus 30 deg. The dead load was estimated at 11·2 lb. per square foot, this amount including an allowance of 5 lb. per square foot for snow. The positive wind load was taken at 15 lb. per square foot and the suction wind load at 10 lb. per square foot. The stresses allowed conform to the British Standard Specification No. 449/1937. All the roof members are of angle section, and in the case of tie members, half the outstanding leg was neglected in the calculation of the area, the area of one rivet hole being deducted in addition in the case of the riveted design. With the exception of the rafters, all struts were designed with both ends held in position and one end restrained in direction since no horizontal bracing was provided in the plane of the main tie. The rafters were designed on the assumption of both ends fixed, but due allowance was made for bending stresses set up by purlins placed between the points of intersection. In the roof as completed the purlins are of 6 in. by 2½ in. timber, pitched at 3 ft. 4½ in. on the rafters and attached to them by 5 in. by 3 in. by ⅜ in. angle cleats. The roof structure consists of the rafters as the top members with a main horizontal tie at the wall-plate level. The main tie is supported in the centre by a suspension member from the ridge point. A main strut at the centre of each rafter and perpendicular to it runs to the tie. On each side is a subsidiary strut also perpendicular to the rafter. The lower of these subsidiary struts runs into the main tie and the upper one into the member running from the point of intersection of the main strut and the main tie up to the ridge point. The frame is completed by a pair of diagonals from the point of intersection of the main strut and the rafter to the point of intersection of the subsidiary struts with their outer members. Each truss is, therefore, divided into six triangular panels.

The welded design was lighter than the riveted one due to the elimination of the gussets required at all points of intersection of the latter, the several members being simply lapped over and welded, though the main economy of weight lay in the members themselves. The rafters in both designs were the same size, viz., 3½ in. by 3 in. by ½ in. angle, but the main tie, 2½ in. by 2 in. by ½ in., in the riveted design, is 2 in. by 2 in. by ½ in. in the welded one. The tie suspension member remains the same, viz., 2 in. by ½ in., as does the main strut, viz., 3 in. by 3 in. by ½ in. angle. The subsidiary struts and other members are, however, much lighter, 2 in. by 2 in. by ⅜ in. angles being replaced in the struts by 1¾ in. by 1¾ in. by ⅜ in. angle and in the other members by 1½ in. by 1½ in. by ⅜ in. angles. Theoretically, some of these members could have been made still lighter, since the stresses are considerably below the allowable limits, but smaller sections were not obtainable and would, moreover, have been lacking in stiffness though not in strength. It should not be overlooked, however, that the size of the members in the riveted design was to a large extent determined by the rivet size.

The welded truss shows a saving in weight of 18 per cent. and the actual weight proved to be in exact agreement with that calculated. It is a fair assumption, therefore, that the calculated weight of the riveted truss, which weight was used in the comparison, was also accurate and the saving in weight is, in consequence, a reliable figure. As regards comparative cost, this, also, is between an estimate and an actual cost, but a careful record was kept and there does not appear to be any reason for over-estimating the cost of the riveted design. The saving in labour costs was approximately 37 per cent. in favour of the welded design.

One of the completed trusses was tested by dead-weight loading. Weights of 8¼ cwt. each were hung from each intersection point on the rafter, and produced in the main tie an extension of ¼ in. This might have resulted from the straightening of this member, which was originally slightly curved. An additional 8¼ cwt. was then added at each of the intersection points on one side of the truss only, this being intended to represent the vertical component of the wind pressure. On the application of this load a further extension of the main tie by approximately ⅛ in. occurred. On removal of the whole of the loading no permanent set could be detected.

Apart from reduction in weight and economy in cost, it is claimed that a welded roof truss has other advantages. The plane of the members is more nearly true and therefore more in conformity with theoretical design; the absence of gussets and the use of smaller sections conduces to better lighting for the same area of glazing, appearance being, incidentally, improved. Corrosion in a roof truss usually starts round rivets, that is, in the areas under the heads which paint cannot reach. All parts inaccessible to paint in a welded truss are completely sealed, and a smaller corrosion allowance can therefore be made.

We are indebted to Messrs. Murex Welding Processes, Limited, Waltham Cross, Herts, for the information on which this article is based.

THE WORK OF THE STEEL COMMITTEE OF THE AMERICAN SOCIETY FOR TESTING MATERIALS.

As a result of a representative series of meetings which took place during the "Committee-Week" of the American Society for Testing Materials, held in Washington, from March 3 to 7, the Society's Committee A-1 on Steel resolved to submit, by letter ballot, six new specifications for the approval of its 229 members. While all these specifications are of importance, four are considered particularly significant, namely, those relating to low-alloy structural steel; light gauge structural quality carbon-steel sheets (two specifications); and alloy and carbon-steel blooms, billets and slabs for forgings. Of the two other specifications, the one dealing with hot-worked high-carbon steel railway-sleeper plates will be offered for immediate adoption as a standard, and the other, covering ring and disc forgings, is to be issued as a tentative standard.

The new specifications for low-alloy structural steel, drawn up by a section of which Mr. C. F. Goodrich, chief engineer, American Bridge Company, is chairman, concern steel having a composition conducive to weldability, intended primarily as the main stress-carrying material in structural members. These specifications limit the thickness of the material to from ⅛ in. to 2 in., and the maximum permissible carbon content in the ladle analysis is 0·20 per cent. (check analysis, 0·22) and the maximum manganese is 1·00 (check analysis, 1·05). It is stipulated that the manufacturers shall use alloying elements which, combined with the carbon, manganese and sulphur limits, will yield properties meeting the minimum values specified. The tensile strengths specified for this grade of steel range from 28 tons to 31 tons per square inch, depending upon the thickness, while the relatively-high yield points, which characterise various compositions within this class, range from 17·85 tons per square inch, for material from 1¼ in. to 2 in., in thickness to 22·30 tons per square inch for thinner material.

An important development in the work of Sub-Committee II on Structural Steel for Bridges, Buildings and Rolling Stock, is that of the section on the welding of structural steels, under the chairmanship of Mr. Jonathan Jones, chief engineer, Fabricated Steel Construction, Bethlehem Steel Company. This section reached agreement on changes which might be made in the standard specifications for steel for bridges and buildings (No. A 7-39) to cover the weldability of the material. One of the important problems was to specify chemical limits, particularly for carbon and manganese, and also to prescribe physical properties, but these have now been laid down.

The two new specifications relating to steel sheets have been in course of development for many months by a sub-committee headed by Mr. E. F. Lundeen, of the Inland Steel Company, and were preceded by intensive work on the part of manufacturers in correlating data and information so that the various requirements could be based upon the latest practice. For several years there has been a persistent demand that Committee A-1 should establish quality standards for hot-rolled sheet material not included in the various plate specifications. Hence, the specifications, one of which deals with sheets ranging from 0·0478 in. to 0·1874 in., and also to 0·2499 in. in thickness, and the other with materials from 0·0477 in. to 0·0225 in. in thickness, should be of considerable interest.

In both specifications, the maximum carbon allowed for open-hearth steel is 0·25 per cent. and for acid-Bessemer steel 0·10 per cent., with appropriate limits for phosphorus, sulphur and copper, when copper steel is specified. Each specification prescribes four grades. The first is a commercial grade, which is subject to a bend test only, while for the heavier gauge material the minimum tensile strength of the remaining three grades is 21·43 tons, 23·19 tons, and 24·55 tons per square inch; for the lighter gauge the figures are 20·09 tons, 22·30 tons, and 23·19 tons per square inch, respectively. With regard to the proposed new tentative specifications for carbon-steel and alloy-steel blooms, billets, and slabs for forgings, many controversial points have been discussed and settled in a section under the chairmanship of Mr. D. R. Carse, of the Climax Molybdenum Company. The tentative standards drawn up are to be referred for approval by letter ballot, and, when adopted as standard, they will supersede the existing standard No. A 17-29. At the Washington meeting substantial agreement was reached on the major points at issue. A note in the specifications indicates that they relate to material suitable for forgings covered by four other A.S.T.M. specifications: namely, No. A 235-40 T, dealing with carbon-steel forgings for general industrial use; No. A 236-40 T, concerning carbon-steel forgings for locomotives and cars; No. A 237-40 T, relating to alloy-steel forgings for general industrial use; and No. A 238-40 T, dealing with alloy-steel forgings for locomotives and cars. The chemical requirements for over 30 types and grades of material are stated, the carbon and manganese ranges being specified as well as those of the various alloying elements, comprising chromium, nickel, vanadium, and molybdenum. Acceptable limits of chemical composition constituted one of the points on which there was considerable difference of opinion, and, in particular, the percentage of carbon, and the types and grades which should be set up as standard steels were extensively discussed. The section, however, had the benefit of extensive surveys made by the American Iron and Steel Institute on the applications of the various grades of steel, and the new specifications are based on this information.

In justifying its recommendation that the proposed new specifications covering hot-worked railway-sleeper plates should be accepted by the Society, at its annual meeting at Chicago in June, for immediate adoption as a formal standard, Sub-Committee I on Steel Rails and Accessories, headed by Mr. E. F. Kenney, metallurgical engineer, Bethlehem Steel Company, pointed out that this specification was essentially in agreement with the requirements issued some time ago by the American Railway Engineering Association. The fact that export and other organisations utilised other A.S.T.M. standards of quality to cover sleeper plates, however, made it very desirable that there should be a specific standard relating to this material. The specifications concern hot-worked high-carbon steel sleeper plates for general use in standard gauge railway tracks and the carbon content ranges from 0·40 per cent. to 0·80 per cent. The proposed new specifications for carbon-steel and alloy-steel ring and disc forgings, drafted by a section presided over by Mr. A. O. Schaefer, engineer of tests, The Midvale Company, contain lists of nine classes of carbon-steel and six of alloy-steel material. The carbon-steel forgings are classified according to heat treatment and physical properties, the material ranging from untreated to quenched and tempered steel, with tensile strengths ranging from 21 tons to 40 tons per square inch, depending upon the treatment and the size classification. The yield points range from 11·16 tons to 24·50 tons per square inch, and appropriate values for elongation and reduction of area are specified. The six grades of alloy-steel, which range from annealed to normalised, quenched and tempered material, have minimum tensile strength values of from 35·7 tons to 55·8 tons per square inch. The yield point values are from 22·3 tons to 47 tons per square inch. For this specification a ring or disc forging is defined as being one the length of which, as measured on its longitudinal axis, is less than its diameter or major transverse dimension.

One of the recommendations of Sub-Committee VIII on Steel Castings, of which Mr. W. C. Hamilton, research director, American Steel Foundries, is chairman, was that the previously issued tentative specifications for carbon-steel castings suitable for fusion welding for miscellaneous industrial uses (No. A 215-39 T) should be adopted as standards. This sub-committee held an interesting meeting, at which representatives of the Army, Navy and Federal Specifications Board were invited to discuss methods of co-operation for the simplification of specification requirements. As a result of the meeting, further steps are to be taken to effect a working arrangement. A representative meeting of Sub-Committee IX on Steel Tubing and Pipe, presided over by Mr. T. G. Stitt, chief inspecting engineer, Pittsburgh Steel Company, made a number of recommendations. One of these was that all references to temperature ranges in the standard specifications for electric-resistance welded steel pipe (No. A 135-34) should be deleted. At present, the material is limited to an upper service temperature of 450 deg. F. The recommended requirements for copper-molybdenum iron boiler tubes were also decided on. Eventually, this material is to be considered for incorporation in the existing basic standard, No. A 83-40, which deals with lap-welded and seamless steel and lap-welded iron boiler tubes.

DRYING MACHINE FOR COATED WELDING RODS.

MESSRS. THE SPOONER DRYER AND ENGINEERING COMPANY, LIMITED, ILKLEY.

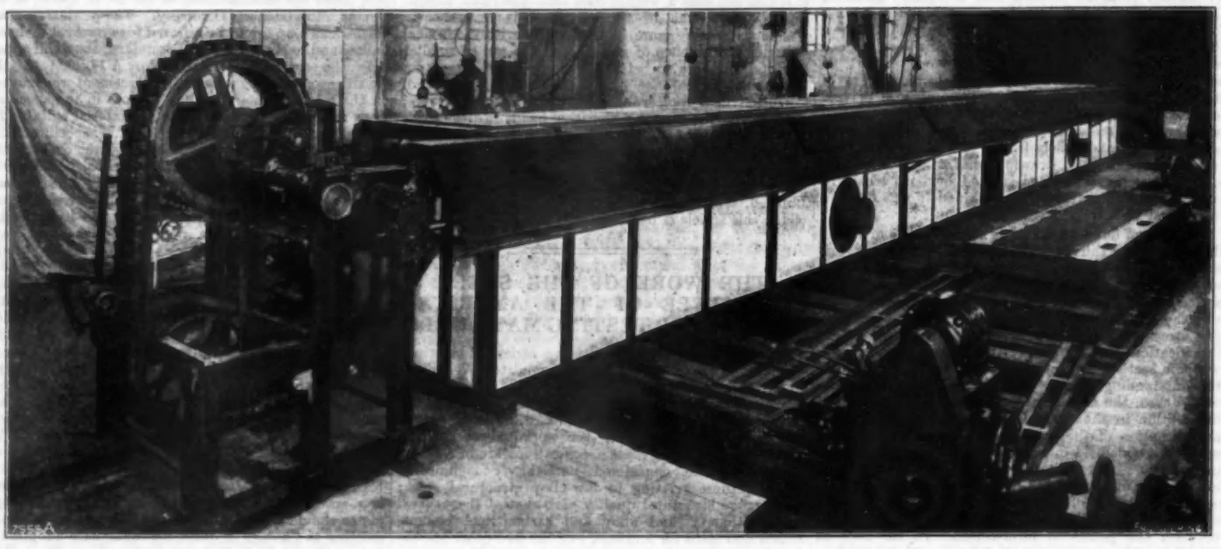


FIG. 1. SINGLE-TIER DRYING MACHINE.

DRYING MACHINES FOR COATED WELDING RODS.

THE increased demand for welding rods which has naturally accompanied the growth of welding, both has and electric, in engineering construction has involved definite changes in technique in the manufacture of these rods, at least as regards the coated type. The rate of production of coated rods is determined, to some extent, by the time taken to evaporate the moisture contained in the coating, since this coating, consisting either of inorganic or organic materials, or a mixture of both, is always applied to the metal core in the form of a paste which has then to be dried. The process of drying one type of coated rod, viz., that in which asbestos or cotton yarn is wound helically round the core and the coating is deposited between the coils, was described in ENGINEERING, vol. 146, page 613 (1938). Briefly, the drying of such rods is effected by placing the wet coated rods in metal trays or racks, which are then transferred to a drying chamber. The speed of production of the rods is limited to about 20 per minute per machine, so that the operator has time to place the rods in the trays which are collected from him. In the manufacture of another type of coated rod, the coating is extruded directly on to the core, there being no winding. The rate of production is, in consequence, higher, and tends to increase. Thus an output of 150 rods per minute per machine, not long ago, was considered good, but an output of twice as many per machine is now common, and even higher rates can be obtained up to 500 rods per minute.

For the extruded coating type of rod, then, it is clear that the tray method of drying could not keep pace with the extruding machines and a continuously-operating dryer is necessary. A general account of a dryer of this type is given below, the manufacturers being Messrs. The Spooner Dryer and Engineering Company, Limited, Ilkley, who also make the hand-fed dryer described in our previous article. Some details of a continuous dryer are shown in Figs. 1 to 3, on this and the opposite pages, while two different layouts are outlined in Figs. 4 to 7, page 370. As is well-known, the materials of which the rod-coatings are composed vary with different makers, so that the drying process is not always of the same character. It is not practicable, therefore, to describe in detail the various types of drying machine employed, but two typical examples are dealt with. A small machine is shown in Figs. 4 and 5. In this the rods covered with the un-set coating are picked up at the left-hand of the machine and passed through it once only, emerging at the right hand with the coating properly dried. The rods are carried on a chain conveyor at a pre-determined speed.

It will be noticed, however, that this machine is not uniform throughout its length, there being two compartments marked "steamer" at the entering end, which differ in construction from the section marked "dryer." This design is employed for those types of coating which have a tendency to dry rapidly, so that a hard crust may be formed on the exterior of the coating before the heat has had time to penetrate right through the coating to the metal core. The want of homogeneity of the dried coating is likely, therefore, to cause cracks to form in it. The two "steamer" sections are fitted to slow down surface drying at the start. The sections consist of chambers constructed of copper and each is provided with a

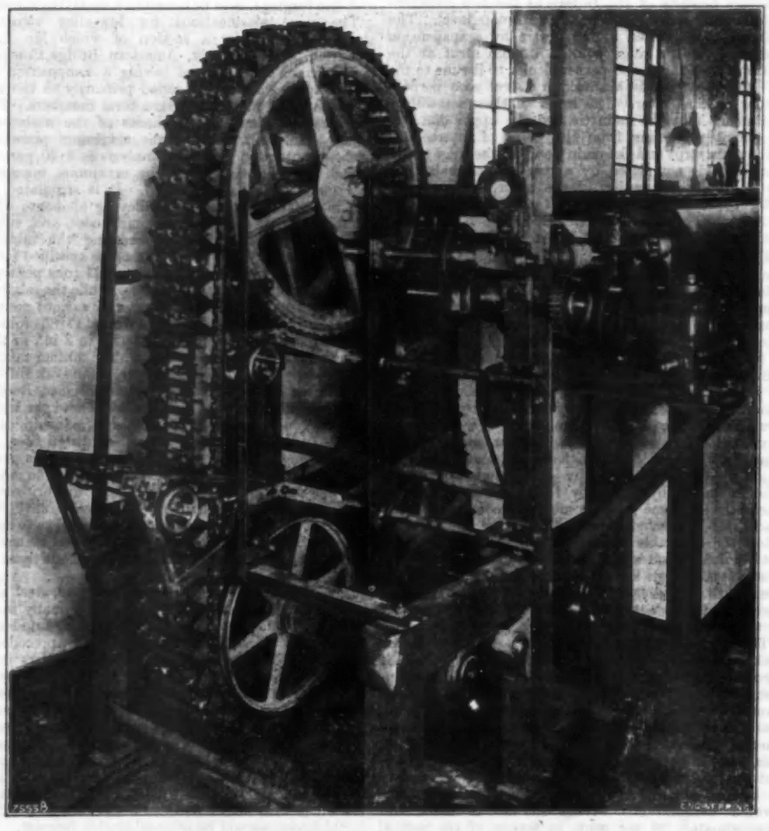


FIG. 2. ELEVATING AND CHAIN SEPARATING GEAR.

GAS HEATER FOR DRYING MACHINE.

MESSRS. THE SPOONER DRYER AND ENGINEERING COMPANY, LIMITED, ILKLEY.

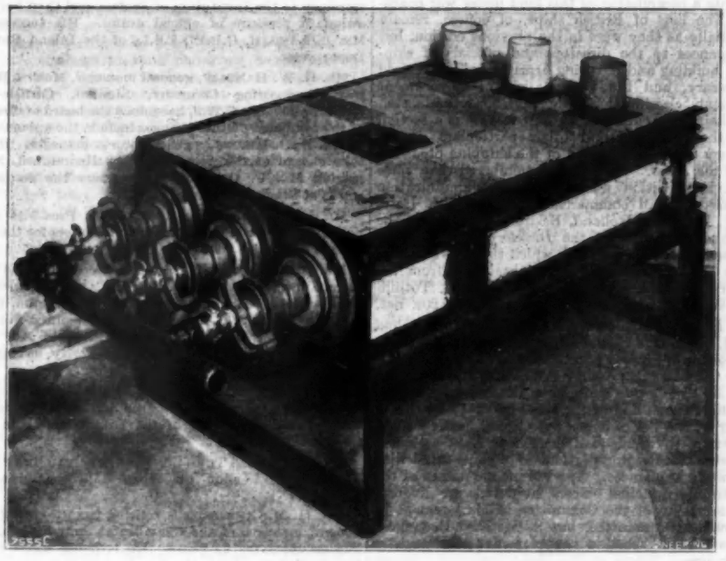


FIG. 3. THREE-BURNER GAS HEATER.

motor-driven fan, which circulates steam, or, more correctly, hot air heavily charged with water vapour, round the rods. The whole rod, including the metal core, is thus warmed up, since no evaporation from the outer surface can take place, and the rods enter the drying section at a uniform temperature throughout their mass, a condition conducing to even drying. The machine shown in Figs. 6 and 7, has no "steamer" sections, and is, at first sight, only slightly larger than that shown in Figs. 4 and 5, since the length of the drying section is 62 ft. 3 in., as against 56 ft. 5 in. A closer examination will show, however, that in the machine shown in Figs. 6 and 7, the rods are passed through the drying atmosphere three times, being carried on that number of chain conveyors arranged one above the other. The rods are fed in at the left on the top conveyor and are transferred automatically to the middle conveyor at the right-hand end. This conveyor runs from right to left, and takes the rods back to the left-hand end, where they are transferred to the bottom conveyor and finally discharged at the right-hand end. This construction, though necessarily more complex than that of a single-pass machine, is of great service in installations where floor space is limited.

It will be noticed, in both Figs. 4 and 5 and Figs. 6 and 7, that the chain conveyors through the machines are not continuous. The conveyor in Figs. 4 and 5 is divided into three sections and each of the conveyors in Figs. 6 and 7 into two sections. This is done to ensure smooth working, as a conveyor chain of too great length develops a surging movement. Each of the sections is driven by worm gear from a common shaft so that there are no difficulties in effecting synchronisation. At the points of junction of the sections the conveyor chains overlap; that is, in plan, the sprockets carrying one pair of chains lie inside those carrying the pair for the next section. The rods are, therefore, transferred without change of rate of motion from one section to the other. The transfer from one conveyor to the next below it in Fig. 6 is effected by means of a rubber belt marked *a*, the conveying chains being indicated at *b*. It will be clear from the arrangement at the right hand of this figure that the rods moving from left to right on the top strand of the top conveyor are constrained by the belt to pass round a semicircular path and, when they leave the bottom strand of the top conveyor they are deposited on the top strand of the middle conveyor which strand is moving from right to left. The same method is adopted at the left of the machine for the transfer of the rods from the top strand of the middle conveyor to the top strand of the bottom conveyor. This conveyor is extended at the right of the machine so as to provide space for convenient removal of the dried rods.

So far the drying process seems simple enough, but there are a number of factors involved which necessitate considerable care and ingenuity in design. It is a prime necessity that the coating should be dried evenly over the whole surface of the rod, a requirement that involves not only precise control of the drying air, but definite precautions in passing the wet rods through it. The latter point will be dealt with first, since the way in which the rods are fed into the drying machine is important and is naturally the beginning of the drying process. A comparatively small single-pass machine is shown in Fig. 1, the feeding end being to the left of this figure. An enlarged view of the feeding mechanism is given in Fig. 2. This particular example is of a rather more complex mechanism than is generally required as the machine has had to be designed to deal with rods either 12 in. or 18 in. in length. The rods are carried through the machine by a pair of parallel conveyor chains, on which the ends only of the rods rest, so that practically the whole of the surface is exposed to the drying currents. To change over from one length of rod to another, one of the chains and its corresponding rail have to be moved laterally inwards or outwards.

The rods must be spaced definitely apart on the conveyor chains in order to prevent contact during their passage through the machine, otherwise uneven drying would occur. The rods are deposited on the conveyor chains by an elevator, which picks them up one by one from a chute to which they are delivered by the covering machine, and it follows that the elevator must be capable of lateral adjustment also, so that its centre coincides with the centre of the conveying chains. There is thus no tendency for the rods to tilt when being transferred from the elevator to the conveyor, since their centre of gravity remains in the same vertical plane through the whole operation of picking up, transferring, and conveying. It is the mechanism for effecting the lateral movements that has complicated the feed gear in the example illustrated, a complication, however, having considerable mechanical interest.

The general construction of the elevator will be clear from Fig. 2. It consists of a pair of roller chains, each passing over a large sprocket wheel at the top and over two grooved pulleys at the bottom. The outer links of the chains carry triangular brackets, a spindle with its ends supported in the corresponding brackets of each chain bridging the transverse gap between the chains. To each spindle is attached a pair of hods, which are receptacles not unlike a bricklayer's hod with open ends. The hods are cross-connected below the spindle by a round bar. The weight of this bar keeps the hod in the same position all round the chain, since the spindle is free in the chain-link brackets. The front face of the elevator thus formed is vertical and passes upwards in front of the frame at the extreme left. The frame is connected with the delivery chute from the coating machine and its inclination may be adjusted by the upper handwheel. The lower hand-wheel regulates an adjustable stop, which arrests the rods, as they roll down the frame, at a point where the platform of each hod picks up one rod and carries it upwards and over the sprocket wheel to be deposited on the conveyor chains. The centring of the rods transversely is effected by the two vertical bars seen one at each side of the lower end of the frame, these bars being inclined slightly towards one another.

The rear face of the elevator lies at an angle to enable the chain sprockets to be so situated that the ends of the conveyor chains overlap this face, an arrangement which will be clear from an examination of the left hand of Fig. 4. At this point the upper and carrying strands of the conveyor chains, which in Fig. 4 run from left to right, are carried over sprockets and then led back as return strands over another pair of sprockets. It is hardly possible to identify these sprockets in Fig. 3, the worm gears at the right, which might be mistaken for them, being part of the width-adjusting gear. The main drive to the elevator sprockets and the conveyor chain sprockets is, however, readily distinguishable, as it consists of an enclosed worm gear, the worm shaft running off to the right to the driving end of the machine. The course of this shaft is indicated in Fig. 5, though this view does not show the same machine as that in Figs. 1 and 2. In Fig. 5, there are three sections of conveyor chain, each taking a drive from the worm shaft, which, in turn, is driven by a variable speed motor, the variation being necessary to give different drying times for different sizes of rod, or rods of the same size with different coatings. The cross-drive from each worm wheel shaft is through a spring-loaded friction clutch, and at each section of the chain is an arrangement which compensates for variation in length arising from temperature changes.

The worm shaft in Fig. 2 runs through the elevator at the back of the delivery face and has mounted on it the two driving sprockets of the conveyor chain. It is, moreover, prolonged beyond the main frame to carry gears for the drive of the elevator chain sprocket. These gears are not distinguishable in Fig. 2, but their situation can be identified in Fig. 1. The drives of both elevator and conveyor being derived from a common source, are, of course, synchronised, and the elevator hods deposit one rod on the "waisted" portions of the conveyor links so that no contact of the rods on the chains is possible. The lateral adjustment gear may now be dealt with. Only one of the two conveyor chains is moved, the distance to change from 12-in. rods to 18-in. rods being thus 6 in., and the consequent shifting of the centre line between the two chains is thus 3 in. The elevator, then, must be moved as a whole through 3 in., so that the centres coincide, for the reason already stated. The elevator sprocket and bottom pulleys are, therefore, mounted with a feather key, so that they can be slid axially along their shafts. The sprocket and pulleys are located transversely by a Tee-shaped frame carried on rods sliding in brackets on the main frame. This locating frame can be made out readily in Fig. 2. It is traversed by three screws, one at the top and two at the bottom. The top screw can be identified as it carries a sprocket wheel over which is a chain drive to the two bottom screws. Rotation of one screw, therefore, causes corresponding rotation of the other two, and the elevator is thus moved axially one way or the other, as required. The sprockets for the conveyor chains are moved laterally by similar action, the screws for this purpose being rotated by the two worm gears seen near the main drive worm gear casing in Fig. 2. The worm shaft of the adjusting gears runs along the machine to the driving end, where the drive is effected by a reversing motor. This conveyor-adjusting gear of a pair of worms and wheels is repeated along the conveyor at intervals of about 8 ft. The elevator-adjusting gear is driven from the conveyor-adjusting gear by a gear of 2 to 1 ratio, not visible in Fig. 2, so that while one conveyor chain moves transversely through 6 in. the elevator only moves 3 in. It will be clear that the variable speed motor and the reversing motor are not normally required to be in action at the same time, since the width should not be altered as long as any rods are passing through the machine.

The feeding and conveying mechanisms having been dealt with, a brief description may now be given of the means adopted for drying the rods. The machine does not consist of a heated chamber, but rather of a long shallow tunnel through which the conveyor passes, the roof and floor of this tunnel being formed with nozzles or slits over the whole width of the rods and communicating with chambers above and below it containing heated air under pressure. The pressure is set up by a number of the firm's patent fans situated at intervals along the machine; thus, in the single-tier machine, Figs. 4 and 5, there are four fans, each driven by a 4-h.p. motor and in the three-tier machine, Figs. 6 and 7, there are six fans, each driven by a 6-h.p. motor. The main body of the air is constantly circulated through the machine, the outer casing, which is effectively insulated against heat losses, forming the return passage. At the same time, a

percentage of fresh air can be introduced, when required, by a set of auxiliary blades on the fans. The function of the nozzles in the tunnel roof and floor is to split up the drying air into a large number of turbulent streams which flow over every part of the wet rods and ensure the maximum degree of evaporation. It might be thought that the longer rods could be equally well dried on the conveyor chains as set-up for the shorter ones, but with this arrangement one chain and its guard would interfere with the air flow over the longer rods and the coating would not be evenly dried. The provision for separating the chains to suit the longer rods eliminates this defect.

The air may be heated in several ways; for example, by a battery of steam-heated tubes at each fan. This is the system adopted in the dryer shown in Figs. 4 and 5, and it will be noted from the latter view that a filter is provided at each fan inlet, the hinged doors in one side of the casing providing access to the filters for cleaning purposes. An alternative method of heating is by gas burners, the products of combustion from which mix with the main air streams and maintain them at the desired temperature. The dryer shown in Figs. 6 and 7 has this type of heating, there being six gas heaters situated as shown by the dotted outlines at the bottom of Fig. 7. The exact design of heater fitted may vary with the drying conditions, but a typical burner for a large machine is shown in Fig. 3, page 367. In this a firebrick chamber is divided into three compartments, each of which serves for a burner of the Selas type. The primary air for combustion enters through the annular space round the gas inlet and the secondary air through that at the connecting flange on the casing, the flow being induced by the fan allocated to the heater. The device seen at the extreme left of the gas-supply pipe is a governor valve. For some applications, the gas burners are thermostatically controlled.

INSTITUTION ELECTIONS.

INSTITUTION OF STRUCTURAL ENGINEERS.

Member.—Harold Glyn Carlile, London; George Bruce Johnston, London.

Associate Member to Member.—William Alexander Fleming, Glasgow; George Henderson, B.Sc., Barbados, B.W.I.

Associate.—Guy Morgan, F.R.I.B.A., Fetcham, Surrey.

Graduate to Associate Member.—Eric Harrop, Manchester; Raymond Lingard, Stafford; Joseph Mitchell, Halesowen, Birmingham; Harry Stuart Morgan, B.Eng., Rochester; Frank Vinden Simmonds, London; John Ernest Stammers, Heston, Middlx.

THE LATE DR. H. S. HELE-SHAW.—An interesting document that has been acquired recently by the Institution of Mechanical Engineers is the apprenticeship indenture of the late Dr. H. S. Hele-Shaw, F.R.S., who was president of the Institution in 1922, and who died on January 30 of this year. It is dated September 17, 1872, and sets forth that, in consideration of a premium of 80*l.*, Henry Selby Hele Shaw was bound apprentice to Edwin Rouch and William Robert Howard Loaker, of the Mardyke Iron Works, Bristol, "to learn the said trade or business of a Millwright and Mechanical Engineer in all its branches," and was to receive wages at the rates of 6*s.*, 8*s.* and 10*s.* a week, respectively, during the three years' term of the apprenticeship. We understand that the indenture has been presented to the Institution by Dr. Hele-Shaw's executor, and is to be preserved in the library with the other documents of a similar kind which are already filed there. A detailed notice of Dr. Hele-Shaw's career appeared on page 114, *ante*, in our issue of February 7, 1941.

LIVERPOOL OBSERVATORY AND TIDAL INSTITUTE.—An incidental effect of the war has been a great increase of work in connection with the supply of tidal predictions, according to the annual report, for 1940, of the Liverpool Observatory and Tidal Institute. War risks, delays in transport overseas, and other reasons, have rendered it necessary to accelerate the normal programme so that predictions can be furnished with certainty at an earlier date than usual. Nevertheless, the tide-predicting machines have fully maintained their mechanical efficiency, each having been twice thoroughly overhauled in the course of the year. In connection with the meteorological equipment, the report notes that a new Short and Mason micro-barograph has been installed to replace the King's barograph. The latter instrument, which has now been accepted by the Science Museum, was of a unique type, the steel barometer tube floating in mercury so that large-scale registration could be effected without mechanical gearing. The instrument had become inefficient; probably, it is thought, on account of a change in diameter of the steel tube due to deterioration of the surface of the steel.

ANNUALS AND REFERENCE BOOKS.

The Directory of Shipowners, Shipbuilders and Marine Engineers.—The 39th edition of this convenient reference book, recently published, shows little obvious sign of the difficulties which attend the task of keeping up to date a compilation of this kind under war conditions. The lists of British ships, of course, remain substantially as they were in the previous edition, but the references to the directors and officials of shipowning, building and repairing firms have been revised as necessary, and the various lists of Government departments, classification authorities, consultants, etc., retain their full usefulness. A new feature is a section giving the addresses and other particulars of the emergency offices in England of the shipping organisations of the Allies. When it is remembered that, since the previous edition was published, communication has ceased for all commercial purposes with Italy, Norway, Denmark, Holland, Belgium and France, the editor and publishers of the *Directory* must be congratulated on the success with which they have carried out the work of revision. It is obtainable from the Directory Publishing Company, Limited, 33, Tothill-street, Westminster, S.W.1, and is priced at 20*s.* net.

The British Corporation Register of Shipping and Aircraft.—We have received from the British Corporation Register of Shipping and Aircraft, 14, Blythswood-square, Glasgow, C.2, a copy of the Register Book for 1941. As usual, this contains a list of registered or managing owners, and of the ships operated by them; together with a list of ships, not classed in the British Corporation, to which load lines have been assigned, and another, containing particulars of ships fitted with refrigerating appliances. Apart from the names of the chairmen and principal officers, no details are given of the membership of the Committee of Management or the Technical Committee, but it is stated that these names will be published in a supplement to the Register in due course.

BOOKS RECEIVED.

The Scientific Photographer. By DR. A. S. C. LAWRENCE. London: Cambridge University Press. [Price 18*s.* net.]

The Practical Application of Aluminium Bronze. By C. H. MEIGH. London: McGraw-Hill Publishing Company, Limited. [Price 17*s.* 6*d.*]

United States War Department. Miscellaneous Series No. 4. (1940 edition.) *Supplement to Port and Terminal Charges at United States Great Lakes Ports.* Washington: Superintendent of Documents. [Price 5 cents.]

Surveying. Theory and Practice. By PROFESSORS R. E. DAVIS and F. S. FOOTE. Third edition. London: McGraw-Hill Publishing Company, Limited. [Price 35*s.*]

International Series in Physics. Applied X-Rays. By PROFESSOR G. L. CLARK. Third edition. London: McGraw-Hill Publishing Company, Limited. [Price 42*s.*]

Design of Concrete Structures. By PROFESSORS L. C. URQUHART and C. E. O'ROURKE. Fourth edition. London. McGraw-Hill Publishing Company, Limited. [Price 31*s.* 6*d.*]

Proceedings of the Institute of British Foundrymen. Volume XXXIII. Session 1939-1940. *Containing the Papers Prepared for the Thirty-Seventh Annual Conference of the Institute and a Selection of the Papers Presented to the Branch Meetings Held During the Session.* Edited by J. BOLTON, Assistant Secretary. St. John-street Chambers, Deansgate, Manchester, 3: Offices of the Institute.

Materials Handbook. An Encyclopedia for Purchasing Agents, Engineers, Executives and Foremen. By G. S. BRADY. Fourth edition. London: McGraw-Hill Publishing Company, Limited. [Price 35*s.*]

Time and Motion Study, and Formulas for Wage Incentives. By S. M. LOWRY, H. B. MAYNARD and G. J. STEGEMERTEN. Third edition. London: McGraw-Hill Publishing Company, Limited. [Price 35*s.*]

Pressworking of Metals. A Reference Book Illustrating and Describing Practical Applications of the Principles Used in the Design of Punches and Dies. By C. W. HINMAN. London: McGraw-Hill Publishing Company, Limited. [Price 28*s.*]

Sewage-Treatment Works. Administration and Operation. By C. E. KEEFER. London: McGraw-Hill Publishing Company, Limited. [Price 42*s.*]

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—A luncheon is being organised by the Institution of Automobile Engineers to take the place of the usual summer meeting. The function will be held at the Savoy Hotel, Strand, London, W.C.2, at 12.45 for 1 p.m., on Friday, June 20. The price of the ticket is 15*s.*, and application should be made as soon as possible to the acting secretary of the Institution, 12, Hobart-place, London, S.W.1.

PERSONAL.

DR. RICHARD SELIGMAN has been appointed chairman of the Condenser-Tube Corrosion Research Sub-Committee of the British Non-Ferrous Metals Research Association.

MR. O. C. WATSON has resigned the office of honorary secretary to the Institution of Professional Civil Servants owing to pressure of official duties. His successor is MR. L. LANHAM, O.B.E., F.S.I., of the Inland Revenue Department.

MR. G. W. HAMBLIN, general manager, Messrs. Broadway Engineering Company, Limited, Carlisle-road, Hendon, London, N.W.9, has joined the board of directors of the company. Other changes include the appointment of MR. H. G. HIRONS as general works manager. He will take charge of the new factory at Hednesford, Staffs, leaving MR. C. OLDFIELD to manage the company's works at Stanmore.

MR. W. E. ROOTES has been elected President of the Society of Motor Manufacturers and Traders for the third year in succession.

MR. R. K. JOPSON, O.B.E., has been appointed Commercial Secretary, Grade I, and MR. W. GODFREY, Commercial Secretary, Grade III, at Washington, U.S.A. MR. S. G. IRVING, C.M.G., has been appointed Commercial Counsellor at Madrid, in succession to MR. J. G. LOMAX, M.B.E., M.C., who will leave shortly, having been transferred to another post.

MR. T. H. GIBSON, secretary of the British Iron and Steel Federation, and of the Iron and Steel Control, has been elected a director of the British Iron and Steel Corporation, Limited.

MESSRS. LE BAS TUBE COMPANY, LIMITED, have transferred their London offices to 23, Montagu-square, London, W.1.

MR. H. M. CLEMINSON is retiring from the position of general manager of the Chamber of Shipping which he has occupied for 25 years. He is being succeeded by MR. P. MAURICE HILL, the deputy general manager.

MR. B. L. BROADBENT has been appointed chairman, DR. G. E. FOXWELL, vice-chairman, and MR. W. S. KNIGHT, honorary treasurer, of the British Chemical Plant Manufacturers' Association for the ensuing year.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—There was a strong demand for practically all grades on the Welsh steam-coal market and every effort was being made to increase the output in order to satisfy the demands of home industrial users and for stocking purposes. Export business was an unfavourable feature of the market. Operators as a rule held well-filled order books from buyers in the markets still open to South Wales and a good demand was still encountered from these sources. Unfortunately, however, exporters were unable to accept much further business and deliveries under existing contracts were in arrears in several instances. Fears were entertained that competing coalfields would be able to consolidate their position in world markets to the detriment of the local trade. The inland trade remained very active and provided a ready outlet for coals displaced from the export section. Dry steam coals were in sustained request for Eire and the tone was firm. Best large coals were active and there was a brisk request for sized coals, which were difficult to secure and commanded high prices. Bituminous smalls were only sparingly offered and were firm, but dry smalls were plentiful and dull. The home demand for cokes was brisk and prices were firm, but patent fuel was quiet.

The Iron and Steel Trade.—Activities in the iron and steel and allied trades were maintained at a high level during the week. In the tinplate industry there was a good demand, but business was rendered difficult by various restrictions. Galvanised and other steel sheet makers were kept busy on Government orders.

THE LATE MR. W. W. MYERS.—It is with regret that we announce the death of Mr. W. W. Myers, which took place recently at his home in Ashton-on-Mersey. Mr. Myers, who was in his 60th year, joined the Carborundum Company, Limited, Trafford Park, Manchester, 17, in 1903. For many years he had served the firm loyally in the capacity of office manager.

BRITISH INSTITUTION OF RADIO ENGINEERS.—The Institute of Wireless Technology and the British Institution of Radio Engineers have amalgamated into a body to be known as the British Institution of Radio Engineers Incorporated with the Institute of Wireless Technology. The first annual general meeting of the newly-formed body will be held in June, when an election of a Council for 1941-42 will be held. The President is Mr. S. A. Hurren and the general secretary Mr. G. D. Clifford, and all communications should be addressed to the Institution at Duke-street House, Duke-street, London, W.1.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—There has been practically no change in the activity of the various Scottish steelworks during the past week. Shipbuilders and boiler-makers are both consuming heavy tonnages. The output is being maintained at the maximum capacity, and as the supply of raw materials is good, this state is likely to continue. Although medium plates are not so active, there is a heavy demand for both black and galvanised sheets. Orders are so numerous that active conditions are assured at the works for many months. The following are the present quotations :—Boiler plates, 17*l.* 12*s.* 6*d.* per ton ; ship plates, 16*l.* 3*s.* per ton ; sections, 15*l* 8*s.* per ton ; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton ; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton ; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—Satisfactory conditions still prevail in the malleable-iron trade of the West of Scotland and most works are fully employed. The re-rollers of steel bars have still a fair amount of work on hand, but the rapidity with which orders were completed during recent months has depleted order-books and fresh business would be welcomed. The stocks of semies are now ample for all requirements. The current quotations are as follows :—Crown bars, 15*l.* 12*s.* 6*d.* per ton ; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton ; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton ; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—The Scottish pig-iron makers are fully occupied with a steady demand from their usual clients. Steelmakers are pressing for deliveries of both hematite and basic iron, and every ton produced is rapidly utilised. The recent improvement in the demand for foundry grades is well maintained, and bookings are satisfactory. Raw material is in good supply. The following are to-day's market quotations :—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works ; foundry iron, No. 1, 6*l.*, delivered at the steel works ; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

THE INSTITUTE OF METALS.—For the first time since it was established, the annual May Lecture of the Institute of Metals (the 31st of the series) is to be held this year at a provincial centre. The meeting will take place at 3.30 p.m. on Wednesday, May 28, at the new Clarendon Laboratory, Parks-road, Oxford, when Dr. F. Simon, M.A., F.R.S., who is Reader in Thermodynamics in the University of Oxford, will lecture on "The Significance of Low-Temperature Research." At the conclusion of the Lecture, tea will be provided in Wadham College, by permission of the Warden and Fellows. Admission to the Lecture is free, by ticket obtainable from the secretary, the Institute of Metals, 4, Grosvenor-gardens, London, S.W.1, or the secretary, the Clarendon Laboratory, University Museum, Oxford.

CONTROL OF LIQUID FUEL FOR FURNACES.—The Secretary for Petroleum has made the Petroleum Order, 1941, which came into force on April 25. The Order contains powers for controlling the consumption of liquid fuel and, in future, no person may use, by burning, any liquid fuel in contravention of a direction given by the Secretary for Petroleum. For this purpose, liquid fuel means (*a*) gas oil, marine gas oil, Diesel oil, marine Diesel oil, fuel oil, heavy fuel oil, marine fuel oil, and any similar product of petroleum or shale, and (*b*) any crude or dehydrated coal tar, carburetted water-gas tar, producer-gas tar, pitch, creosote, blends of creosote and pitch, and any of the oils known as coal-tar oils. The new powers will be exercised immediately to secure the increased substitution of home-produced tar oils for the imported petroleum products at present used. Some consumers had converted their plant to burn tar oils before the war, and many others have since done so. There are still, however, substantial quantities of pitch and mixtures of creosote and pitch available which, in the national interest, must be used to the fullest possible extent. The Petroleum Department, in conjunction with the Petroleum Board, is reviewing the needs and circumstances of each consumer burning petroleum oils, and notice will be given in suitable cases to consumers of any change in the type and quantity of liquid fuel which they will be permitted to use in future. Before tar oils can be used satisfactorily some alteration in plant may be necessary and the Petroleum Board, which is marketing the oils, is ready to make available the services of its technical experts to advise on the details of conversion. The new Order, which revokes the Petroleum (No. 1) Order, 1940, is being published as Statutory Rules and Orders 1941, No. 546, and copies will shortly be on sale, price 2*d.* (net), through any bookseller or directly from H.M. Stationery Office, York House, Kingsway, London, W.C.2.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—The usual buyers of iron and steel have virtually withdrawn from the market, realising that orders for ordinary commercial undertakings cannot be dealt with at present. War-time requirements continue to absorb almost the whole of the supply, which is being maintained at a very high level. Raw materials and semi-finished products are plentiful. The output of ironstone from the Cleveland mines has been increased. Basic and high-phosphorous pig are in ample supply and stocks of blooms, slabs, etc., are substantial. There is still, however, some shortage of hematite pig.

Cleveland Iron Trade.—There is a steady increase in the demand for foundry iron, but no difficulty is experienced in obtaining satisfactory deliveries. The shortage of Cleveland qualities attracts little attention as the delivery of Midland brands is adequate for the requirements of the North East Coast foundries. The recognised values of Cleveland pig remain at the level of No. 3 description at 128*s.*, delivered in the Middlesbrough district.

Basic Iron.—While the heavy output of basic iron covers the requirements of the makers' own steel-producing plants, it provides no surplus for other users and the quotation remains nominal at 120*s.* 6*d.*

Hematite.—The outlook in the hematite industry shows signs of improving. The prospects of any material expansion in the make are slight, but imports of American hematite are expected to increase appreciably in the near future. Meanwhile, the rigid restriction of distribution is essential. Stabilised prices are ruled by No. 1 grade of hematite at 138*s.* 6*d.*, delivered to North of England buyers.

Foreign Ore.—The imports of foreign ores, other than descriptions required for hematite-making, are now adequate for users' needs, owing largely to the substitution of native ironstone.

Blast-Furnace Coke.—Durham blast-furnace coke is abundant, but holders are extensively sold and are unwilling to book new orders until they have reduced their contract obligations. As local users are well covered, market negotiations are few. Good medium qualities are quoted at 35*s.* 6*d.* f.o.r.

Manufactured Iron and Steel.—Satisfactory deliveries of semi-finished iron and steel are keeping the re-rolling plants actively employed. In the finished industries outputs are approaching the maximum and there is a brisk demand for nearly all descriptions of material. Heavy constructional steel is in greater request than formerly and the demand for light rolled commodities, steel plates for shipbuilding, boiler-making and tanks, sheets and special alloy steels is unabated ; supplies of railway requisites are quickly taken up. Soft steel billets are quoted at 12*l.* 5*s.* ; hard billets at 13*l.* 12*s.* 6*d.* ; joists and sections at 15*l.* 8*s.* ; heavy ship plates at 16*l.* 3*s.* ; and heavy rails at 14*l.* 10*s.* 6*d.*

Scrap.—Although the deliveries of iron and steel scrap are very extensive, more is needed, especially of heavy grades of material.

ELECTRICAL EQUIPMENT FOR MACHINE TOOLS.—The Controller of Machine Tools has appointed Mr. S. F. Steward electrical adviser in charge of a branch of the Control to give advice and direction on all matters connected with electrical equipment for machine tools. The branch's chief responsibility is to ensure that no machine tool is idle owing to delay or difficulty with electrical equipment. If any such delay or difficulty is experienced or anticipated, the department should be advised in time for appropriate action to be taken. All communications regarding electrical equipment for machine tools and electric welding equipment should be addressed to the Ministry of Supply (Code V.A.), Machine Tool Control (MTC. 8), 35, Old Queen-street, S.W.1. (Telephone : VICtoria 9040, Ext. 287 or 273.)

EXHIBITION OF A.R.P. EQUIPMENT.—An announcement made by the Ministry of Home Security states that a comprehensive exhibition, illustrating the various methods of protection of glass in houses, factories and shops, glass substitution and ventilation and obscuration in the black-out, is being staged simultaneously at the Building Centre, 158, New Bond-street, London, W.1, and 425, Sauchiehall-street, Glasgow, C.2, and at the Manchester Municipal School of Art, Cavendish-street, All Saints, Manchester, 15, and the Museum and Art Gallery, Queen's-road, Bristol. Exhibits from more than 150 firms will be shown in London and all have been submitted to the Research and Experiments Department of the Ministry. Representatives of local authorities, surveyors, architects and the general public are invited to see samples of actual materials and equipment used to carry out the recommendations of the Ministry. A specimen of the new Morrison table shelter will be on view, as well as samples of shuttering for north lights and factory roofs.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF AUTOMOBILE ENGINEERS.—*London Graduates' Section :* Saturday, May 10, 3 p.m., 12, Hobart-place, S.W.1. "Gear Tooth Profiles," by Mr. J. F. Norwood.

INSTITUTION OF THE RUBBER INDUSTRY.—*London Section :* Monday, May 12, 5 p.m., The Chemical Society's Rooms, Burlington House, Piccadilly, W.1. Joint Meeting with the *Plastics Group* of THE SOCIETY OF CHEMICAL INDUSTRY. (i) "Rubber Insulating Materials," by Dr. H. A. Daynes. (ii) "The Part Played by Plastics in the Electrical Industry," by Dr. G. E. Hacfely.

INSTITUTION OF ELECTRICAL ENGINEERS.—*South Midland Centre :* Monday, May 12, 6 p.m., The James Watt Memorial Institute, Great Charles-street, Birmingham. Annual General Meeting. Faraday Lecture : "Electric Traction," by Mr. C. E. Fairburn.

ROYAL SOCIETY OF ARTS.—*Dominions and Colonies Section :* Tuesday, May 13, 2.30 p.m., The Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. "Research in Canada," by Lieut.-General A. G. L. McNaughton. *Society :* Wednesday, May 14, 2.30 p.m., The Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Ordinary Meeting. "Partnership on the Scale of Modern Industry," by Mr. J. S. Lewis.

INSTITUTION OF CHEMICAL ENGINEERS.—Tuesday, May 13, 2.30 p.m., The Geological Society's Rooms, Burlington House, Piccadilly, W.1. Joint Meeting with the *Chemical Engineering Group* of THE SOCIETY OF CHEMICAL INDUSTRY. "Economical Raising of Steam in Small and Medium-Size Boiler-Plants," by Dr. G. W. Himus.

INSTITUTE OF PHYSICS.—*London and Home Counties' Branch :* Tuesday, May 13, 6 p.m., Messrs. Kodak, Limited, Harrow. "Thermal Effects in Transformations in Metals," by Dr. C. Sykes.

INSTITUTION OF MINING AND METALLURGY.—Thursday, May 15, 3 p.m., The Geological Society's Rooms, Burlington House, Piccadilly, W.1. Annual General Meeting. (i) Report of Council and Accounts for 1940. (ii) Presidential Address, by Mr. E. H. Clifford.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The general position of the iron and steel trade shows little change. The flow of orders for all types of steel products has been maintained, and outputs at all the large steel and engineering works show an increase as compared with a year ago. Producers of raw and semi-finished materials are exceptionally busy. Large batteries of furnaces, many extended during the past six months, are accounting for record outputs. Much of the steel is being used for the production of equipment for the Forces, though a considerable tonnage is being taken up for the manufacture of commercial goods. The malleable-iron trade shows further improvement. Mills, forges, and foundries are uniformly busy. The demand for steel ingots and castings, and also for billets, shapes and joists, is believed to constitute a record. Large supplies of drop stampings are on order. High-quality alloy steels are freely specified where the stampings are required for the production of heavily stressed engine parts. There is great activity in the heavy machinery and engineering trades. Steelworks' and ironworks' machinery is in demand, while business in heavy types of grinding and crushing machinery and dredging plant is increasing. The demand for railway rolling stock shows some improvement. Local works specialising in the production of tramway points and crossings of manganese steel have extensive orders on hand from provincial corporations. Business in electrical equipment is also increasing. Power-station extensions have created a demand for hollow forgings and boiler drums, and steel used in the manufacture of transformers, generators, and other heavy plant is being ordered in large quantities. Electric motors for traction purposes are on order, some being required for export to South Africa and South America. There is a steady flow of overseas orders for Sheffield-made machinery, but the volume of business being done shows a decline over the past year. Among the plant on order are concrete mixers, lime hydrators, rotary dryers, dust-collecting plant, and coal-crushing machinery. The tool-making trades are operating at full capacity.

South Yorkshire Coal Trade.—The demand for all classes of coal has been maintained, but larger quantities are available for consumers. Buying for stocking purposes is a feature in some grades. Steams are in good request, and the house coal market is more active. Foundry and furnace cokes are steady.

DRYING MACHINE FOR COATED WELDING RODS.

MESSRS. THE SPOONER DRYER AND ENGINEERING COMPANY, LIMITED, ILKLEY.

(*For Description see page* 366.)

Fig. 4.

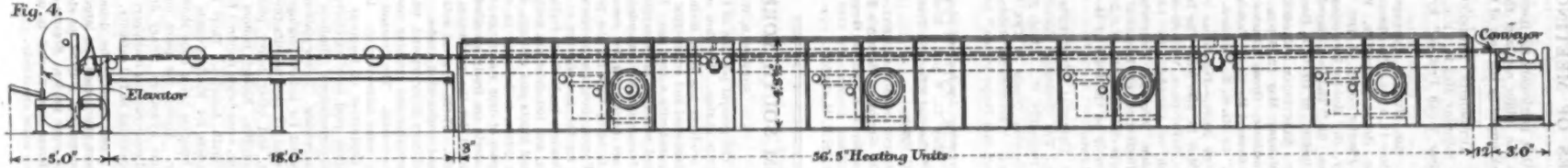


Fig. 5.

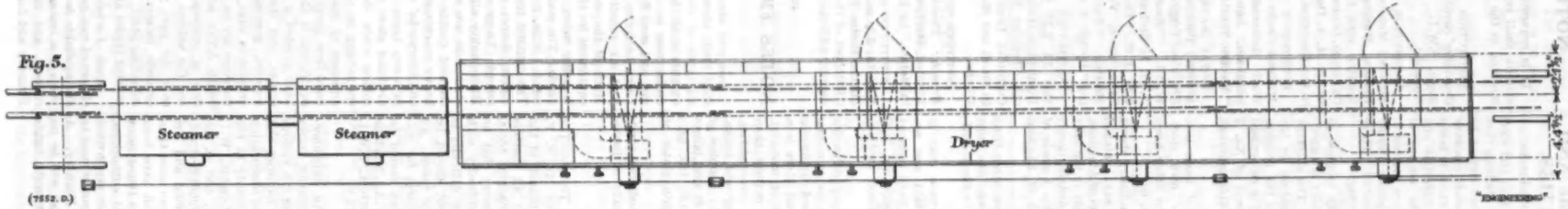
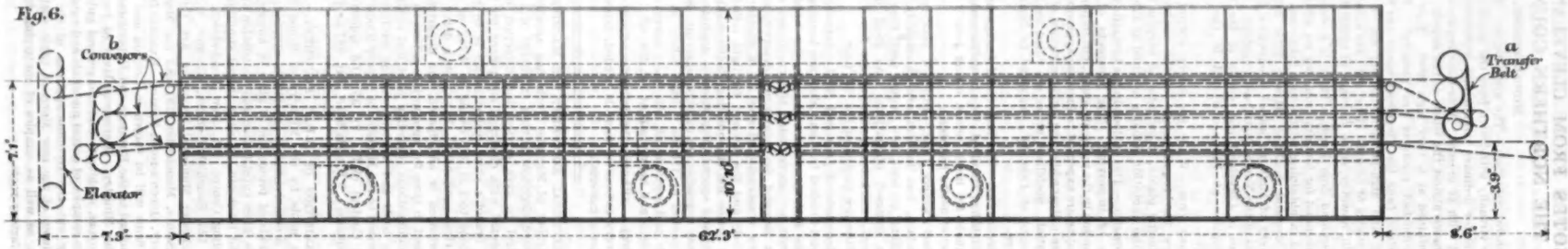


Fig. 6.



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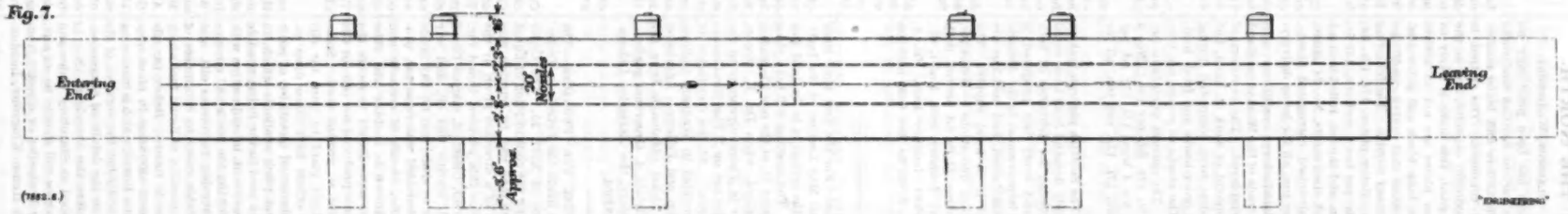

RAID SPOTTER'S POCKET BOOK AND LOG.—Messrs. Charles Letts and Company, Diary House, Borough-road, London, S.E.1, have recently issued an interesting little book entitled *The Raid Spotter's Pocket Book and Log*. This has been compiled by a member of the Royal Observer Corps, and contains illustrated descriptions of the W.E.F.T. (wings, engines, fuselage, tail) method of identifying aircraft; types of British, American and enemy aircraft; and German parachute troops' uniform, equipment and weapons. In addition, detailed instructions are included for the guidance of roof and other watchers. These comprise data on visual spotting, sound spotting, the use and care of prismatic binoculars, the times of fall of bombs, the war gases likely to be used, and hints on fire fighting. At the end of the book there are a number of blank log pages for noting down occurrences and the times saved by industrial works as a result of "spotting"; blank identification pages for the noting down of particulars of new aircraft; blank duty-roster pages, and plain ruled pages for notes. The book measures 5¼ in. by 3¼ in., and, bound in cloth and fitted with a pencil the price is 1*s.* 6*d.* net

THE COLLECTION OF SALVAGE.—The Ministry of Supply informs us that the total sales of the salvage collected by local councils realised 198,992*l.* in February, as compared with 187,720*l.* in January. The metal salvaged increased from 16,808 tons, valued at 44,988*l.*, in January, to 19,307 tons, valued at 56,754*l.*, in February. The tonnage of paper collected in February showed a slight decrease, amounting to 21,441 tons, against 22,123 tons in January. Bones collected in February, namely, 834 tons, showed a decline of 74 tons as compared with January. In comparing these figures, however, it must be borne in mind that February is a short month and that the severe snow storms in the third week caused much interruption of the collection services. Moreover, the figures of sales given above take into account only collections by local authorities. They do not include material collected by merchants; neither do the metal returns include the Village Dump or the Railway Schemes. Preliminary figures for March, full details of which are not yet available, indicate a further all-round improvement in salvage collection. These figures will be issued shortly by the Ministry of Supply.

ENGINEERING.

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ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns, of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of Publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

All accounts are payable to "ENGINEERING," Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

CONTENTS.

	PAGE
The Grand Coulee Dam (*Illus.*)	361
Literature.—Reinforced Concrete Chimneys. The Suspended Matter in the Nile: Report on Investigations Relating to Aswan Reservoir	362
Effects of the War upon South American Markets	363
Welded Roof Trusses	365
The Work of the Steel Committee of the American Society for Testing Materials	365
Drying Machines for Coated Welding Rods (*Illus.*)	366
Institution Elections	368
Annuals and Reference Books	368
Books Received	368
Personal	368
Notes from the South-West	368
Notes from the North	369
Notes from Cleveland and the Northern Counties	369
Notices of Meetings	369
Notes from South Yorkshire	369
The University and Industry	371
Shipping and Transport	372
Notes	373
The Iron and Steel Institute	374
Labour Notes	376
500-H.P. Diesel-Electric Locomotive (*Illus.*)	376
The Direct Production of Magnesium	377
The Formation and Properties of Martensite on the Surface of Rope Wire (*Illus.*)	378
High-Speed Band Saw	380
"ENGINEERING" Patent Record (*Illus.*)	380

Two One-Page Plates.—GRAND COULEE DAM ON THE COLUMBIA RIVER, WASHINGTON, U.S.A. MARTENSITE ON MINING HAULAGE-ROPE WIRE.

ENGINEERING

FRIDAY, MAY 9, 1941.

VOL. 151. No. 3930.

THE UNIVERSITY AND INDUSTRY.

THE greater part of the mental work of the world is done by a very small proportion of its population ; most people are engaged on routine jobs. One brand of sociologist is fond of dwelling on the monotonous nature of the work entailed by modern mass-production industry and on its deadening influence on the mental processes of the workers, but it is difficult to see that the activities of the operatives in, say, an electric-lamp factory, or a packing warehouse, are essentially more repetitive than are those of a bank teller. This latter individual, however, and tens of thousands of others in the various branches of industry and commerce are not usually favoured with the commiseration thus bestowed on the manual worker. Most of this commiseration is misplaced and unnecessary. Although a large proportion of people, if fate dictates, are capable of displaying initiative and resource, they prefer, in normal life, to be left alone to carry on with work they can do with little mental effort. As Mr. Ralph E. Flanders pointed out in the address on "The University and Industry," which we reprinted on page 356 of our issue of last week, "by far the greater percentage of mankind is happiest in a routine job."

It is probably not realised by the general public to what extent the world relies on quite a small number of people for any progress it may make. Parenthetically, some may suggest that it is showing no signs of progress at the moment, but this is to confuse moral and material values. The ethic which has endured for two thousand years is once more challenged by the doctrine of the jungle. That with fortitude and toil it will again establish its reign, there is no question, and the incidence of the present conflict is no evidence of retrogression in the material advance on which the modern structure of life is based. It is within the framework of this material advance that the age-long doctrines of what is right must to-day operate. The attack they have to meet will be the better parried as the material basis of civilisation, which is their present embodiment, is the more firmly established. It is no reply to say that the powers of darkness have equal access to the facilities of an advancing material civilisation. They have not. At the beginning they had ; they were living on the achievements of the past. To-day, their activities hamper and, given time, may destroy the mental bases on which material progress rests. They carry the seeds of their own dissolution.

The few odd thousands who, in Mr. Flanders' words, are responsible "for the well-being and security" of the millions are not supermen, but they have an originality of mind and a confidence which enables them to face and solve new problems. The number of people in this, or any, country able to contribute fundamental advance in, say, the design of aeroplane engines, is few. These few have naturally had advantages in training and experience bearing on the particular problems concerned, but there are many of their fellows of similar credentials who, none the less, have not the ability, or possibly it is the confidence, to make similar contributions to progress. Not all those who constitute the advance guard of civilisation are designers or engineers ; they are to be found in every branch of activity. The engineers among them are, however, of especial importance. As Mr. Flanders said, engineering is nearly the foundation of modern industry, and industry is nearly the foundation of modern life.

There is no broad distinction between the few who lead and the many who follow. One class merges into the other. With the geniuses, the few individual outstanding men, we are not here concerned. They are born that way. Among the thousands who form the advance guard, however, there are many degrees of ability and the class shades off into the mass which prefers an occupation which does not require too much thinking. As progress and hope for the future lie in the hands of those who are prepared to take responsibility and to think for themselves, it is a matter of the first importance that their numbers should be increased. This is the text of Mr. Flanders' address. As was proper, in view of the occasion of its delivery, he confined his attention to the university as the recruiting ground ; though well knowing, no doubt, that this is by no means the only agency for the supply of leaders. It is, however, one of the chief. It cannot create ability, bit it can do much to foster it.

As industry and the whole basis of material existence become every day more dependent on technical advance, so every day the importance of a scientific outlook in those who form the van of engineering progress increases. As Mr. Flanders pointed out, the whole of the members of this class may not be best served by a uniform type of technical education ; he suggested three types of curricula, one for technicians, one for executives, and one for "engineers in the strictest sense." The distinction between education for the latter class and for technicians is already well recognised in this country and is provided for by universities of the older type and by technical colleges. The matter need not be enlarged on here. The question of education for executives, however, is a different case. If the best, from the point of view of the good of the State, is to be made of the possibilities of progress provided by the advance of engineering and other scientific industries, it is necessary not only that improvements should be made in the design offices and the shops, but that full advantage should be taken of them in their application. For this it is necessary that administrators as well as producers should be imbued with the spirit of modern science.

The importance of a scientific education for those who direct affairs becomes every year more important as the rate of progress is accelerated. The advances which have followed the organisation of research are well known, at least in engineering circles, but the remarkable decrease in the time interval between discovery and application is perhaps not so generally realised. The matter was put in a striking way by Dr. William E. Wickenden in an address delivered on the same occasion as that of Mr. Flanders. He pointed out that eighteen centuries elapsed between the turbine of Hero of

Alexandria and the earliest practical application of steam by Savery in 1698, followed by a century and a quarter before Carnot submitted its cycle to fundamental analysis and another thirty-five years before Rankine reduced the analysis to an effective working tool. In the much later case of the dynamo, only thirty years passed between discovery and practical application, while with radio telegraphy, but ten years separated the discoveries of Hertz from the applications of Marconi, a period but little longer elapsed between Thomson's researches on the conduction of electricity through gases and De Forest's production of the three-element valve.

In a world in which fundamental discovery becomes practical application in so brief a period, it is vital for the well-being of the State that executive officers and administrators should be able to appreciate the potentialities of the complicated and rapidly changing mechanism with which they have to deal. Not only should they be capable of independent thought, but they should have a scientific training. This means that over wider ranges of modern life they should be engineers of the best type. The virtual exclusion of the technical man from the leading, and higher paid, administrative posts has long been a matter of discussion and controversy. It it frequently said that engineers are not good administrators. We have sometimes wondered whether this idea has been fostered by administrative Civil Servants in order to retain their own hold on affairs. There are very many engineers running successful businesses and running them all the better because they understand the details of what they are doing. It is also many years now since the large engineering combines found it desirable to have their leading technical men on the board.

This is not to say that an engineer's training is naturally adapted to create an administrator. The fact that it has been realised that something more is necessary is illustrated by the inclusion in recent years of economic subjects in the entrance examination for the great engineering institutions. So far, however, there has been little deliberate provision for engineers to extend their economic and business training, and the institution of a five-year course to that end at Cambridge University, recorded on the opposite page, is a matter of considerable importance. The Institution of Civil Engineers is to be congratulated on the enterprise and foresight which has led it to initiate and to undertake to finance this new movement, which will ultimately extend the number of business enterprises controlled by men who understand the implications and possibilities of modern technical advances.

There is a touch of genius in the selection of Cambridge University as the seat of the new training scheme. It might have appeared more natural to choose one of the leading technical colleges, but the great advantage of Cambridge—or Oxford—is the absence of any control by the Board of Education or similar Government bodies. Cambridge was presumably preferred because of its famous engineering school. Any form of regimentation of higher education by political authority is in every way undesirable, even in purely technical spheres. In the training of executives and administrators it might well be disastrous. An example of what direct Government control can do to higher education is furnished by the condition of affairs now ruling in Germany. Mr. Churchill, in one of his great war speeches in the House of Commons, on August 20, 1940, said, "Since the Germans drove out the Jews and lowered their technical standards, our science is definitely ahead of theirs." Not merely by expelling able scientific men because of their race, but by imposing political control on all teaching, Germany has reduced her universities to an intellectual state nothing less than contemptible. This is all to the good from our point of view, as ultimately it must have important reactions on the quality of the German war effort. Activities of the German type are not likely in this country, but an extension of Government controls of various kinds is not impossible and it is a good thing that the Institution of Civil Engineers should have turned for its new training proposals to a university that has a tradition of intellectual freedom extending over so many hundreds of years.

SHIPPING AND TRANSPORT.

DURING the past fortnight, there have been made some of the most important changes in transport organisation, especially in connection with shipping, that the urgency of war has yet induced. On May 1, it was announced that, among other Government re-arrangements, it had been decided to merge the Ministry of Shipping and the Ministry of Transport into a single department, to be known eventually as the Ministry of Wartime Communications, at the head of which would be Mr. F. J. Leathers, deputy chairman of Messrs. William Cory and Sons, Limited, and, for some time past, Adviser on Coal to the Ministry of Shipping. Lieut.-Colonel J. T. C. Moore-Brabazon, the former Minister of Transport, became Minister of Aircraft Production in succession to Lord Beaverbrook; and Mr. Ronald Cross, formerly Minister of Shipping, was appointed High Commissioner for Australia. The announcement added that the amalgamation of the two departments would be effected as quickly as possible, and that certain functions of the Ministry of Transport not intimately connected with communications would be transferred to the Board of Trade or to other departments as might prove desirable.

From this combination of the two Ministries there should result a material improvement in the condition of affairs at the ports, about which there has been much justifiable criticism. Hitherto, it is evident, the division of responsibility in the handling of incoming cargoes has resulted in a certain lack of co-ordination, with consequent delay in clearing goods from the quays to their destinations and an obvious increase in the risk of damage by air bombardment. Some good has been done by the recent appointment of special directors in certain areas, but their effectiveness was necessarily limited by the need to bring about the collaboration of two sets of officials, belonging to the respective departments. If the new amalgamation does no more than avoid these difficulties, it should justify its promotion. In present circumstances, the nation cannot afford that ships should take almost as many weeks to discharge their cargoes in British ports as they took days to load in foreign ports.

An attempt was made to alleviate the congestion by the institution of special fleets of road transport vehicles, operated under the direct control of the Ministry of Transport. This innovation was introduced by Lieut.-Colonel Moore-Brabazon during his brief term of office, but there has hardly been time yet for the effect to become manifest. It may be presumed that his policy, in this respect, will be continued, but according to *The Times*, there is reason to believe that more far-reaching unification of effort is contemplated, which will directly affect the railways. No details have been disclosed of the nature of the changes that may be in contemplation; but, as indicated in our leading article on March 21, the railways are already under Government control so far as finance is concerned, through the medium of the Railway Executive Committee, which was under the direction of the Ministry of Transport and now becomes a committee of the new Ministry. It may be supposed, therefore, that the further unification will take the form of a wider degree of common user and a corresponding diminution of the clerical work which normally arises from the excursions of rolling stock on to "foreign" metals; possibly coupled with some reduction in the services linking the main centres of population by more or less parallel routes, as an alternative to the suggestion put forward in a recent report of the Select Committee on National Expenditure, that passenger traffic should be temporarily suspended at intervals on certain important routes, in order to effect a more speedy clearance of goods from the ports. It may be that this suggestion will have to be adopted in the end, but there are difficulties in the way of its practical application which may well cause it to be deferred until the alternative courses, now rendered possible, have been fully explored.

The second of the changes in transport organisation, referred to in the opening paragraph, has attracted less public attention, but is of considerable interest to those who have followed the fortunes and, still more, the misfortunes, of British shipping during the past decade. It was announced on April 24 that the Chamber of Shipping of the United Kingdom, and the Liverpool Steam Ship Owners' Association had agreed upon certain arrangements for co-operative working "which, while leaving unimpaired the identity and individuality of each of them, are designed to ensure unity of action and policy on questions of major importance to the industry as a whole and the strengthening of the existing arrangements for co-operation between the Association and the Liner Section of the Chamber." The first step to be taken under this agreement is the establishment of a General Council of British Shipping, representing both organisations and all sections of the industry. The second step is to set up a new Liner Committee, which will look after the liner interests of both the Chamber and the Association. Following the resignation of Mr. H. M. Cleminson, on account of ill-health, from the position of general manager of the Chamber of Shipping, which he has held with such conspicuous success for the past 25 years, Mr. P. Maurice Hill, the deputy general manager, has been appointed to that position. Mr. P. Maurice Hill and Mr. Martin Hill, joint secretary of the Liverpool Steam Ship Owners' Association, are to act as joint secretaries of the new General Council and of the Liner Committee.

It is tempting to ask why so obviously desirable a co-ordination should have been delayed so long; for there is good reason to suppose that, had the industry as a whole been more effectively unified in the years before the war, when it was struggling so desperately against the after-effects of the long depression and the unfair competition of foreign subsidised tonnage, the necessary Government assistance might have been more promptly secured, and on a more generous scale than was the case in fact. Had this end been achieved, the present shipping position, almost certainly, would have been less serious. There is little useful purpose in such reflections at this stage; but we may hope that the closer co-operation which is indicated by the formation of the General Council may be effective in maintaining the position and the policy which the industry must maintain if its future, and that of the nation which it serves, is not to be sacrificed to the mistaken ideals and the intensive competition which it will certainly have to combat as soon as the war is over. The conflict of ideals, indeed, may not be postponed so long as that, and it will be a prime duty of the new Council to ensure that the present emergency is not made an excuse for action which will impair the ability of the industry to adjust itself effectively to meet post-war conditions.

Yet more changes are foreshadowed, which will affect materially the conditions of employment afloat. Such details as have been hinted at have been officially disclaimed, but, as we write, the actual intentions of the Ministry have not been disclosed. It is obvious, however, that the problem of manning the new fleets that are coming into being at home and overseas, as well as those ships of enemy and enemy-occupied countries which have been laid up in foreign ports and are being taken over by the Allies, must become increasingly acute. The modifications that have been made to the Ministry of Shipping regulations governing the examinations of masters, mates and engineers, as recently announced in the Ministry' Notice No. M. 197, indicate the urgency of ensuring a sufficient supply of officers. The concessions to engineers relate to the acceptability as qualifying sea service of service in Government vessels, and in circumstances in which the candidate was not the senior engineer in charge of the whole watch. The relaxation in favour of deck officers extends to them a concession already available to engineers, in allowing candidates, whose service abroad has prevented them from sitting for the Second-class Certificate of Competency, to sit for the First-class Certificate if they have obtained the necessary experience. As a further war-time measure, temporary certificates may now be granted as Mate and Second Mate. These, again, are expedients which might well have been adopted at least a year ago. Undoubtedly, they will help to relieve the shortage of officers, but they will not begin to solve the problems of manning which will arise when American shipbuilding on British account reaches full production.

NOTES.

THE INSTITUTION OF CIVIL ENGINEERS.

THE Rt. Hon. Lord Reith, Minister of Works and Buildings, was the principal speaker at the luncheon of the Institution of Civil Engineers, held on Wednesday, April 30, at Grosvenor House, Park-lane, London, and, in proposing the toast of "The Institution," took the opportunity to survey briefly the functions of his Ministry and the general outlines of its policy. Having taken over the duties of the former Office of Works, he premised, the Ministry of Works and Buildings was responsible, primarily, for the provision, maintenance and repair of some 14,000 Government buildings throughout the country. In addition, it was carrying out an immense building programme which represented over 1,000,000*l.* of work a week. It had an office staff of 9,000, half of whom were technical, and a field force of 14,000; but, he added, his was not a gargantuan Department, about to seize the work of individual engineers and architects—"I believe in individuals and we intend to make full use of them." One of the Ministry's achievements had been the substitution for the old priority system of a system of allocation to departments in terms of labour, so that the amount of work permitted was limited to the capacity of the building industry, which was about 350,000,000*l.* of work per annum. Control had been established, also, over many building materials. Unnecessary building, unnecessary demolition and clearance, and extravagant reconstruction were also being controlled. A new department had been formed to help in the rapid repair of damaged houses, services and factories. They were aiming at such a combination of all sections and interests as would make for a radical and permanent improvement in their structure and operation. With regard to the other side of the Ministry's functions—that of advising on the constitutional and administrative machinery necessary for post-war planning and reconstruction—Lord Reith thought that engineers, in particular, should welcome planning in this larger sphere, "instead of the haphazard, confused disorder and inconvenience of our lives, the monstrous and obscene mutilations of the countryside." We were engaged, he declared, in conclusion, in a struggle for the standard of living, economic and cultural throughout the world. Life and war were all engineering achievements of a kind; an inspiration, a design and a plan; organisation and difficulties innumerable; quite likely, disasters. It was the essence of engineering, having counted the cost, to take the risk; "we look beyond war as an engineer looks to the completion of the job—we look to the end." Sir Leopold Savile, the President of the Institution, in acknowledging the toast, said that the Council had given much consideration to the question of post-war development, and several committees were investigating different aspects of it and were keeping in touch with the Ministry of Works and Buildings in the matter. The Council had also co-operated with the Government departments concerned on the subject of engineering education, with the result that Students of the Institution, who had reached the age of 18, could secure postponement of their calling-up on production of a certificate from the secretary that they were engaged as engineering learners and were studying for the associate-membership examination. Moreover, the Council had approached the Vice-Chancellor of the University of Cambridge with an offer to finance the establishment of a Lectureship in the Economics and Aesthetics of Engineering Design and Construction, with a view to the eventual inclusion of these subjects in the Mechanical Science Tripos. The proposal had been favourably received and there was every prospect of making a start in the matter by forming a panel of eminent engineers who would give lectures during the coming winter. Sir Leopold referred also to the appointment by the Government of the Engineering Advisory Committee. The proposal for the establishment of such a committee had come first from Mr. J. R. Beard, president of the Institution of Electrical Engineers, at a meeting of the Engineering Joint Council, last December. With the approval of the Councils of the eight constituent institutions, their presidents sent a joint letter to the Prime Minister, suggesting its formation. Interviews were subsequently arranged to define the details of the terms of reference and to consider the membership, the Government being anxious that the new committee should not represent particular institutions so much as the various branches of engineering activity. It was hoped that such an Advisory Committee would be of value, not only during the war, but also in post-war development. The only other toast on the list was that of "The Guests," which was proposed by Professor C. E. Inglis, F.R.S. (vice-president), and acknowledged by Captain Austin Hudson, M.P., Civil Lord of the Admiralty, who alluded to the close relations which existed between those responsible for Admiralty constructional works and the Ministry of Works and Buildings.

NEW INDUSTRIES IN NORTHERN IRELAND.

The New Industries Acts, passed in 1937 by the Government of Northern Ireland, are still being used to a certain extent to encourage the establishment and development of industrial undertakings, according to the Budget statement presented last week by Mr. J. Milne Barbour, Minister of Finance. Although, so far as new transactions are concerned, they are largely in abeyance during the war, their operation has resulted in placing in useful production between 20 and 30 factories which had been vacant and, in some cases, derelict. In addition, three new factories have been erected. The total of the loans so far made is 210,057*l.*, of which 185,414*l.* is still outstanding; and this assistance is computed to have brought about the employment of nearly 2,500 persons. Repayments of loans continued to be made regularly as they fell due, Mr. Barbour stated; and in some instances where, because of the war, the projected undertakings could be proceeded with only partly or not at all, the parties concerned have voluntarily proposed to refund the money advanced to them. In general, however, the assisted industries do not appear likely to be seriously affected by war conditions.

INSTITUTION OF ELECTRICAL ENGINEERS.

The annual report of the Institution of Electrical Engineers for the year ended March 31, 1941, was presented at the sixty-ninth annual general meeting, which was held yesterday, Thursday, May 8. During the twelve months, the membership rose from 19,872 to 20,275, including 10,121 corporate members, and it is noted that during the last fifteen years the increase has been 7,626, which compares with an increase of 6,110 for the preceding fifteen years; in other words, the membership has more than trebled in the last thirty years. Moreover, though during the first three years of the last war there was a substantial decrease, in both 1939-40 and 1940-41 there has been an increase. Twenty-eight members have received honours and distinctions, including one George Cross, and 31 have suffered death through enemy action, this number including Dr. C. H. Merz and his son; two members of the staff have also been killed. Both in September last and in December the question of holding regular meetings was considered, but it was reluctantly decided that such a course would not be possible so far as London was concerned. One meeting, at which the presidential address was delivered, was, however, held last October, and the second, for the delivery of the Kelvin Lecture, took place yesterday. As an alternative, papers have been circulated and written discussion upon them for publication in the *Journal* has been invited. Throughout the year the Institution has co-operated closely with the Ministry of Labour and National Service in the working of the electrical section of the Central Register. In the course of this work a number of matters have arisen, among which are the formulation of special plans for training young engineers to fill vacancies in certain categories in which there is a shortage of suitable candidates, adjustments from time to time in the Schedule of Reserved Occupations, and the employment of engineers in official appointments above the former maximum age limit of 55. An arrangement is in operation with the Ministry of Labour to ensure that members who are liable for military service are posted to technical branches of the Forces, and it has been decided that students who join the Forces shall be allowed to extend the time during which they may remain in that class by a period equal to the length of their war service. A scheme for the technical education of men in the Forces has also been prepared, and over 2,000 applications have been received for tuition in the various engineering courses. The appointment of an Engineering Advisory Committee by the Government is noted with satisfaction. The Council have set up a Post-War Planning Committee to consider the various problems affecting electrical engineering which will no doubt arise after the war. During 1940, 1,275 National Certificates and Diplomas in Electrical Engineering were issued in England and Wales, and 48 in Scotland. The sectionalising of the *Journal*, to which we have already drawn attention, is mentioned, and the interesting suggestion has been made that it might be possible to exchange abstracts of papers in the proof stage with the American Institute of Electrical Engineers and the Institute of Radio Engineers.

THE REPAIR OF BOMBED PROPERTY.

An important statement on the conditions which now cover the repair to damage caused by air raids was made by Mr. G. Hicks, Parliamentary Secretary to the Ministry of Works and Buildings, in the House of Commons last week. The Government, he said, had given absolute priority over all other work to first-aid repair work for essential public services, war factories and houses. In the case of householders, where the owner was unable or unwilling to carry out the work himself, the responsibility rested on the local authority. Where the owner himself put the repair work in hand, he would require a licence if the work was of the nature of reconstruction and cost 100*l.* or more. The owners of shops, offices, banks, warehouses and other industrial and commercial buildings, including factories not engaged to an important degree on war production, must apply for a licence if the work of reconstruction was to cost more than 100*l.* Applications were referred to the Board of Trade, who recommended that a licence be granted only if it considered that the work was urgently necessary in the public interest. Factories engaged on war production were dealt with by licence or otherwise in consultation with the appropriate Government department. Until recently there had been no attempt to license reconstruction of air raid damage repair in cases in which the cost was below 500*l.*, but a new Order had just been issued and all such reconstruction costing 100*l.* or over required a licence or an authorisation; it was intended to enforce this. No priority, Mr. Hicks added, was given to larger business premises as against damaged homes.

VISIBILITY BY WHITE AND COLOURED LIGHT.

In a paper on "Visibility by White and Coloured Light," which was read before a meeting of the Illuminating Engineering Society on Tuesday, April 8, Mr. J. S. Dow said that the matter of the ease with which objects illuminated by white or coloured light could be seen or recognised at a distance had come into prominence in connection with A.R.P. problems. As far as general outdoor lighting was concerned, the use of colour was, on the whole, inexpedient, as it tended to attract attention and could only be employed on a large scale by subtractive processes, which were essentially uneconomical. To obtain anything approaching pure blue light from an incandescent electric lamp, for example, it was necessary to employ filters which reduced the light to less than 1 per cent. of its original value. At low intensities of illumination the eye was much more sensitive to the blue end of the spectrum than to the red. The apparent brightness derived from a green or blue source might be much greater than that from a red source. At very low levels, sense of colour was lost; red objects appeared black and blue objects a faint grey. This was complicated by the fact that the centre of the eye, which was used in normal levels, was more sensitive to red. The degree of colour selection also depended on atmospheric conditions. There was a tendency for the light of the shorter wavelengths to be more

readily absorbed and scattered by minute particles. Acuteness of vision, too, was affected by colour. The majority of people found that, in the case of distant vision (more than 10 ft.), it was difficult to focus on blue and correspondingly easy to get sharp vision of red, while for close vision the reverse applied. This was due to the lack of achromatism of the eye. Regarding the rapidity with which objects could be recognised, colour appeared to have little effect. Experiments showed that the use of pure blue light in preference to white of equal brightness, while possibly making it more difficult for the dark-adapted eye to examine an illuminated object closely, rendered it easier for the eye to become aware of its existence. For very close vision, however, there seemed to be some advantage in using pure blue and violet light, more especially in connection with processes where the eye was brought very close to the object for long periods or where glasses had to be used for magnification purposes.

THE ACQUISITION OF FACTORY PREMISES.

It is announced that Sir Cecil Weir, who was recently appointed by the President of the Board of Trade to be Controller-General of Factory and Storage Premises for the purpose of centralising and co-ordinating the allocation of accommodation to Government departments, will be assisted at the headquarters organisation by Sir Thomas Barlow, Deputy Controller-General and Factory Controller, and by Mr. P. A. Warter, Storage Controller. Regional Controllers of Factory and Storage Accommodation have also been appointed in each of the Civil Defence Regions, while a Regional Co-ordinator at headquarters will act as a link with the regional organisation and where necessary will be available to assist regional controllers in areas that have suffered from air raids. The object of these officials will be to prevent competition between the various Government departments, either for their own purposes or on behalf of firms working for them. From the date on which the scheme begins to operate, all departments will therefore have to obtain the approval of the Control, through the regional controllers, before acquiring factory or storage premises. Approval having been obtained, the actual requisitioning or leasing will be carried out by the Service departments or by the Ministry of Works and Buildings. The Control will co-operate closely with the latter Ministry and to facilitate its operation will establish a register of factory and storage premises. This register will show which premises can most readily be made available for other purposes without detriment to other important work or to employment and the purpose for which they are most conveniently and suitably equipped. It is hoped that the section of the register dealing with factory premises will be ready by the end of this month. It will be based on a *questionnaire* which is being sent to all factories employing ten or more persons, except those wholly or mainly engaged in the engineering and munition industries and in the trades included in Group I to Part II (Protected Establishments) of the Schedule of Reserved Occupations and Protected Work. Until the register is available the Regional Controllers will give the best help they can to departments seeking accommodation. In this they will have the assistance of the Ministry of Works and Buildings, and will also have at their disposal particulars of the space made available as a result of the concentration of industry policy. The operation of the new Control will affect the acquisition of factory and storage premises by private interests to the extent that firms will only be allowed to transfer their activities to new premises if there are reasons of national importance to justify the move. At the same time, it will minimise the risk of a firm having its new premises requisitioned as soon as it is installed in them.

THE UNITED STATES COAL INDUSTRY.—Owing to a strike in the industry, the average daily production of bituminous coal in the United States during the week ending April 12, amounted to only 206,000 tons, against 660,000 tons in the preceding week and 1,283,000 tons in the corresponding week of 1940.

THE IRON AND STEEL INSTITUTE.

THE seventy-second annual general meeting of the Iron and Steel Institute was held at Grosvenor House, Park-lane, London, W.1, on Thursday, May 1. The proceedings opened with a luncheon, during the course of which the Bessemer Gold Medal for 1941 was presented to Dr. T. Swinden, director of research, Messrs. The United Steel Companies, Limited. After the luncheon an afternoon session was held for the transaction of official business and the presentation and discussion of three papers.

LUNCHEON.

The chair at the luncheon and at the subsequent meeting was occupied by the President of the Institute, Mr. John Craig, C.B.E., who, when presenting the Bessemer Medal to Dr. Swinden, stated that the award was in recognition of the value of his original investigations in the metallurgy of steel, and of his eminent services in the organisation and direction of research in the steel industry. In addition to researches on the influence of tungsten and molybdenum in steel, Dr. Swinden had latterly investigated the properties of cold-rolled steel and questions relating to the control of grain size. He had built up one of the finest research organisations in this country, and, as chairman or vice-chairman of several of the committees or sub-committees of the Iron and Steel Institute and the British Iron and Steel Federation, was taking a leading part in the joint research activities of the industry. Mr. Craig added that, for the present, the award took the form of a token medal; the actual Gold Medal, he said, would be presented to Dr. Swinden on the return to normal conditions. In acknowledging the receipt of the Medal, Dr. Swinden said that, deeply sensible as he was of the great honour conferred upon him, he regarded it as not merely a personal award, but as a recognition of the work of the collaborators with whom he had worked for several years. He also regarded it as a further incentive to service to the Institute and to the industry.

When proposing the toast of "The Iron and Steel Institute and Industries," Mr. R. G. Menzies, Prime Minister and Minister for the Co-ordination of Defence, Australia, said that the people of this country were not only at war, but in the war, and to win a total war it was necessary to have a total organisation. The present war was one in which factory organisation and the machine were much more eloquent than at any other time in history. The efficiency of the British Army depended not only on the courage and skill of the men comprising it, but on the number of the vehicles, tanks and guns with which they were equipped. The work which was being accomplished by the heavy industries was of such vital importance that everyone connected with it should be regarded as being on active service, and nothing could adequately express the debt which the Empire owed to the iron and steel industry. When, some years ago, Australia had embarked upon the production of iron and steel, there had been some misgivings in the Mother Country regarding the wisdom of this step. Now, thanks to its iron and steel and heavy industries, Australia was a source of supply of munitions, and never a week passed that he did not express his gratitude to the men who had laid the foundations of these industries on a firm and broad basis. In responding to this toast, Mr. Craig agreed that a few years ago some people in the United Kingdom had been perturbed at the decision to develop an iron and steel industry in Australia. A country so richly endowed in iron ore, limestone, coal, and other raw materials, however, was bound to make steel, and technical men in this country were fully conscious of the excellence of the plant in Australia and of the talents of the men who administered it. The Iron and Steel Institute, which had always aimed at improving the quality of ferrous products, was now coming into its own, and the steel supplied to the Services was not inferior to any made elsewhere. The Institute was also doing great work in developing the critical mind among young men in the industry. Mr. Craig then proposed the toast of "The Guests," in the unavoidable absence of the Earl of Dudley. In his reply, H.E. Monsieur Josef Bech, Foreign Minister of the Grand Duchy of Luxembourg, paid a tribute to the memory of Thomas and Gilchrist, whose work had made possible the rise of the great steel industry in his country.

REPORT OF THE COUNCIL.

The first business at the afternoon session was the presentation of the Report of the Council for the year 1940. This showed that the number of members on the roll of the Institute, on December 31, 1940, was 2,666, compared with 2,704 on December 31, 1939. The names of 97 members resident on the Continent, whose subscriptions had not been paid before the end of the year, had been placed on a suspense list. Moreover, in accordance with the by-laws, four honorary members, one life member and 73 ordinary members of German or Italian nationality had ceased to be members of the Institute. The Council recorded with regret the deaths of 26 members, which had occurred during the year; these included Sir Harold Carpenter, F.R.S., Colonel R. E. B. Crompton, C.B., F.R.S., Mr. John Gjers, Sir Robert Hadfield, F.R.S., Mr. T. E. Holgate, Mr. D. C. Lysaght, Dr. C. H. Merz, Mr. O. F. A. Sandberg, Mr. L. W. Schuster, Mr. H. Spence Thomas, and Mr. H. B. Toy. As far as the circumstances of the war permitted, friendly relations with other scientific societies and technical institutions in Great Britain, the Dominions, and the neutral countries, were maintained. The Council particularly valued the many signs of friendship which had been received from the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers. Collaboration with the Institute of Metals had been continued on the same close footing as in former years. There had been an increase of 46 in the number of members and associates who were also members or student members of the Institute of Metals, and these now totalled 682. Collaboration with the Iron and Steel Industrial Research Council had been continued on the same basis as in previous years, and 59 meetings of the various joint research committees of the Institute and the British Iron and Steel Federation and of their sub-committees had been held during 1940, as compared with 56 in 1939.

REPORT OF HONORARY TREASURER.

The statement of accounts, prepared by Mr. J. Henderson, the honorary treasurer, showed that while the income of the Institute, apart from special contributions from industrial concerns, decreased from 14,224*l.* in 1939 to 13,807*l.* last year, the expenditure had been reduced by 1,555*l.*, namely, from 18,279*l.* in 1939 to 16,724*l.* in 1940. The income from special industrial contributions increased by 867*l.*, namely, from 4,166*l.* in 1939 to 5,033*l.* last year, resulting, after transference to reserve and other accounts, in a final excess of income over expenditure for 1940 of 530*l.*, in place of an excess of expenditure over income of 228*l.* during the previous year. Further contributions had been received to the Institute's House Fund, the total, as shown in the balance sheet, standing at 14,505*l.* on December 31, 1940.

ELECTION OF OFFICERS.

At this stage of the proceedings the Secretary announced the names of the members of the Council, who, having retired by rotation, were re-elected for a further period of office, no other nominations having been received. These comprised three vice-presidents, namely, Mr. Arthur Dorman, Mr. J. S. Hollings and Mr. C. E. Lloyd, and five members of Council, namely, Captain H. Leighton Davies, Mr. I. F. L. Elliott, Principal C. A. Edwards, F.R.S., Mr. E. F. Law, and the Hon. R. G. Lyttelton.

The Secretary also announced that the Williams Prize of 100*l.*, for 1940, had been awarded to Mr. B. Yaneske, for his paper, "The Manufacture of Steel by the Perrin Process," and that Carnegie Research Scholarship grants, each of the value of 100*l.*, had been awarded to Mr. M. Balicki, of University College, Swansea, in aid of a research on the cold-hardening of steel, and to Mr. H. Morrogh,

of the British Cast-Iron Research Association, in aid of a research on sulphide inclusions in cast iron.

REPORT OF OXYGEN SUB-COMMITTEE.

The first contribution to be discussed by the meeting was the "Third Report of the Oxygen Sub-Committee," a summary of which we hope to publish shortly. In presenting it, Dr. T. Swinden, the Chairman of the Sub-Committee, said that the object of the present Report was to state the position reached in the various methods of determining oxygen in iron and steel, and to indicate the successes, the possibilities and also the limitations of the methods employed. It was necessary to devise a method which would determine oxygen in steel with the same ease and rapidity with which carbon could now be determined. It was recognised that oxygen was an all-important chemical reagent in steelmaking and it seemed wrong that there was no method at present available for determining this element during the manufacture of open-hearth steel. It was felt that, with such a facility, it would be possible to make better steel or possibly speed up the process without detriment to the quality of the melt. Some satisfaction, however, could be drawn from the fact that in the present difficult circumstances it had been possible to present a report at all. His own view, quite definitely, was that this research should not be regarded merely as an academic piece of work. It was a matter of vital importance in steelmaking, and the sooner the work was completed, or taken to a more advanced stage at which it could be applied in works laboratories, the sooner would metallurgists be in a position to improve their steel or augment their output.

Mr. Vernon Harbord, in opening the discussion, stated that while fully appreciating the value of the work done in endeavouring to determine total oxygen, he felt that the distribution of oxides, and the fineness of that distribution, was rather more important than the total oxygen content of the steel. Mr. R. Percival Smith, the next speaker, after congratulating Dr. Swinden and his collaborators and referring to the great volume of research work in progress in various fields of the industry, asked whether, within measurable time, a method for determining the oxygen content of steel, on the furnace stage before tapping, would be made available. Dr. R. J. Sarjant, who spoke next, stated that while the Sub-Committee was endeavouring to devise rapid methods for determining oxygen in steel, he wondered whether they could, at the same time, give attention to a quick method of determining the gases present. Many of the troubles encountered in steelmaking could not be ascribed to oxygen, but were due to gas. Dr. Sarjant also inquired what were the limits of error to be expected, in the methods described in the Report, due to laboratory work and due to methods of taking the sample.

Mr. D. A. Oliver thought that the work done on the fractional method of determining oxides was of outstanding importance, because it seemed to be increasingly apparent that some of the inclusions were present as sub-microscopic particles. There appeared to be increasing evidence, however, that oxygen by itself was not a bad thing. In other words, heats which were allowed to solidify with only silicon and manganese present did not have bad mechanical properties; in some cases, they could have excellent mechanical properties. The same steel melted in as nearly as possible the same manner and de-oxidised with a more energetic de-oxidiser, such as aluminium or zirconium, might have inferior mechanical properties on account of the sub-division of the inclusions. If, however, a reproducible deoxidising procedure could be adopted on repeated casts of steel, it was perfectly clear that, within practical limits, a high degree of uniformity could be achieved. In his own works this had been put into operation during the past two years and the success, as regards uniformity of product, had worked out at over 98 per cent.

In a brief preliminary reply, Dr. Swinden said that he entirely shared the view that the question of the ultra-microscopic distribution of oxide inclusions was of importance. Mr. Smith had asked whether we were within measurable distance of the time when it would be possible to determine the oxygen in the steel before a bath was tapped. That was the goal at which he personally was aiming, and he believed there were possibilities of determining within a reasonable time, at least the more easily reducible oxides, namely, FeO and MnO, which those concerned with the work thought were the most important from the point of view of refining. Dr. Sarjant, of course, realised that in the vacuum fusion method, the nitrogen and the hydrogen, as well as the oxygen, were determined. As to Dr. Sarjant's remarks concerning sampling and how the results should be correlated between the bath and the ingot, or billet, or bar, it was well known that the hydrogen content varied, but in the experience of the Sub-Committee it varied always in one direction, namely, it tended to be reduced as between test samples taken from the bath right down to the bar, and, furthermore, the hydrogen content was reduced on standing even at room temperature. In his view, the limits of error in sampling far outweighed the limits of error in determination, although, as had been stated quite frankly in the report, the Sub-Committee did not consider they had reached the end of the effort on methods of determination. As regards oxygen, it could be said, however, that this element could be determined by the vacuum fusion method to a degree of accuracy at least equal to that pertaining to any other element in steel, and he believed the same could be said of nitrogen and hydrogen. In answer to Mr. Oliver, he had no doubt at all that the time would come when it would be possible to say definitely what was the best method to employ to deoxidise a melt and obtain optimum properties in the resulting steel.

METALLOGRAPHY OF GRAPHITE FLAKES AND INCLUSIONS IN CAST IRON.

The second and third papers on the agenda, both of which were by Mr. H. Morrogh, of the British Cast-Iron Research Association, were taken together for the purpose of discussion. The first of these, namely, "The Polishing of Cast-Iron Micro-Specimens and the Metallography of Graphite Flakes," was reprinted in our columns on page 297, *ante*. Mr. Morrogh's second paper was entitled "The Metallography of Inclusions in Cast Irons and Pig Irons." In this paper, the author classified inclusions into five groups, the first comprising manganese sulphide, iron sulphide and composite inclusions of these two. Group II contained pink inclusions; Group III, white or faint-grey inclusions; Group IV, inclusions produced by alloying with zirconium; and Group V, inclusions produced by alloying with aluminium. In his general conclusions, the author stated that there appeared to be a fairly general agreement that the terms "inclusion," "slag inclusion" and "non-metallic inclusion" were not very satisfactory for the collective description of these small particles in the microstructure of cast iron. The literature of ferrous physical metallurgy demonstrated the chaos of ideas on the subject, brought about in the first place by the lack of enforcement of an exacting definition. In quite a large number of references, the particles were dealt with as a separate group of constituents entirely different from the major phases of the metallic matrix, with the implication that they were insoluble in either the solid or the liquid metal.

Portevin and Castro had shown how difficult it was to subdivide "inclusions" into metallic and non-metallic groups, and they had suggested that the following arbitrary classification could be made, namely, that the term "inclusions" should cover silicates, aluminates, oxides and sulphides, and that nitrides, carbides (and borides and perhaps phosphides) should be included in the term "metallic constituents." This grouping, continued the author, would be very difficult to apply to cast iron, since the only metallographic inclusions would be the sulphides. So far, the metallographist had not been able to detect oxides or silicates of iron, manganese or aluminium in ordinary commercial materials. Inclusions had been stated to be the cause of a number of obscure phenomena exhibited by cast iron and it had been implied that they had properties peculiar to themselves. A careful metallographic consideration of all the particles dealt with indicated no properties, and, what was more important, no modes of formation peculiar to these particles, which were not exhibited in an entirely analogous way by the major phases of the cast-iron microstructure. It would seem, then, that the essential difference between these particles and the remainder of the metallic phases was the fact that the former occurred in much smaller quantities. With this point in view, it was suggested that these particles could be called "minor phases" to great advantage.

Dr. J. E. Hurst, in opening the discussion, said that his only criticism on the first paper was in connection with the author's statement that specimens could be prepared in something like 15 minutes. He himself was quite certain that he could not prepare a specimen and obtain the results indicated in 15 minutes. He asked the author whether any precautions had been taken to be sure that the last traces of the polishing powder had been eliminated, as it seemed possible for particles of the Diamantine powder to remain embedded in a graphite flake. He further asked the author whether he had considered electrolytic polishing. The most startling thing the author had revealed in his second paper was the absence of oxides and silicates. Still more startling to him was the fact that no oxide inclusions had been found in the samples of aluminium-alloy cast iron, even containing as much as 10 per cent. aluminium. He was concerned with making castings which contained only from 1·5 per cent. to 1·75 per cent. of aluminium, and had had considerable difficulties with particles which were thought to be oxide inclusions.

Mr. T. H. Turner asked the British Cast-Iron Research Association seriously to consider linking up with the Scientific Instrument Research Association, and the microscope makers in carrying on this work still further. It was stated in the first paper that the phosphoric irons did not react quite as well to the author's method of treatment as did other irons. He recommended hard pressure, and working slowly, for polishing, whereas, with high phosphoric irons, it had been found best to use soft pressure and high speeds. Mr. Turner would, therefore, like the author to give particulars regarding speeds of polishing, per second, rather than to quote revolutions per minute, because the dimensions of polishing wheels might differ in different laboratories. A subsequent speaker, Mr. Vernon Harbord, thought that the old method of heat tinting developed by Dr. Stead might possibly give very valuable information regarding these complex constituents in cast iron. A few years ago he had gone to a very great deal of trouble in polishing cast-iron specimens on the lines the author had described, and had found that, when heat-tinted, the specimens could be examined under high powers of the microscope without the general blurring effect obtained in the old days of ordinary polishing. The next speaker, Mr. A. Allison, said that notwithstanding the author's description of his method of polishing, it was obvious that a high degree of personal skill was required. He agreed with the suggestion, made in the author's second paper, that the term "minor phases" should be substituted for inclusions. This would be a very welcome improvement in nomenclature. In closing the discussion, Dr. T. Swinden referred to the possible use of anodic etching, of which some experience had been acquired in connection with steel.

Owing to the advanced hour, the President asked the author to reply in writing. He then thanked the authors of all the papers for their contributions and declared the meeting closed.

CONTROL OF BALL AND ROLLER BEARINGS.—The Control of Ball and Roller Bearings (No. 1 Order), which came into force on April 30, prohibits the purchase or acquisition of any ball or roller bearing except from the bearing manufacturers or for use by the purchaser in production or maintenance of some other article, or under a licence issued by the Minister of Supply. Copies of the Order can be obtained from H.M. Stationery Office, York House, Kingsway, W.C.2, or through any bookseller, price 1d. All inquiries should be addressed to the Bearing Panel, Ministry of Supply, Great Westminster House, Horseferry-road, London, S.W.1.

LABOUR NOTES.

THE financial report of the executive council of the Amalgamated Engineering Union for the half-year which ended on December 31 last states that the combined funds of the organisation at the close of the six months totalled 3,696,546*l.* 2*s.* 11*d.*—an increase of 296,419*l.* 19*s.* 2½*d.* as compared with the position at June 30. The General Fund has increased from 2,008,349*l.* 9*s.* 5½*d.* to 2,291,425*l.* 14*s.* 8*d.*, and the Superannuation Reserve Fund from 1,391,776*l.* 14*s.* 3*d.* to 1,405,120*l.* 8*s.* 3*d.* During the period reviewed, the principal statutory benefits—Donation, Sick, Superannuation, Funeral and Benevolent—cost 240,915*l.* 3*s.* 3*d.* or 22*s.* 11¾*d.* per paying member.

The General Council of the Trades Union Congress have appointed Sir Walter Citrine and Mr. James Kaylor, a member of the executive council of the Amalgamated Engineering Union, as their representatives on the sub-committee drawn from the Joint Consultative Committee to assist the Minister of Labour and National Service in seeing that the need for skilled men in the Service trades is met. The Minister of Labour and National Service has appointed one of his principal officials as liaison officer between the two sides of the Joint Consultative Committee and the Service Departments, to deal with the position.

Information was laid before the General Council of the Trades Union Congress at a recent meeting about communist activities among certain refugee organisations which have been established for cultural and welfare purposes in connection with the various national groups. As, in their opinion, the matter has an important bearing upon the work of the Trade Unions with refugee workers, the Council decided to circulate the information to affiliated unions and Trades Councils.

The seventh national conference on labour legislation, held at Washington in December, condemned the competition which firms subject to the Federal Fair Labour Standards Act are at present having to meet from firms which purposely confine their production and sales to the limits of a single State in order to avoid regulation. It approved a draft State Wage and Hour Bill, recently prepared by an advisory committee appointed by the Secretary of Labour, and recommended that it should be used as a basis for legislation in each State in order to arrive at uniform regulations on hours of work and rates of wages for all workers. It also urged that the committee which prepared the draft Bill should continue to function for the purpose of securing agreement upon methods of inspection and administration which would secure the necessary uniformity in the application of the regulations.

A Department of Labour and National Service has been created by the Australian Commonwealth Government. The functions of the new department will be to deal with various questions of general labour policy, the effective training and placing of all available man-power and the supply of trained technicians to meet the needs of the rapidly expanding munitions production and the requirements of private industries stimulated by war activities. The Government believes, it is stated, that the department will become an instrument for co-operation through which representatives of State Governments and employers and employees will be able to throw their full weight behind the war machine. In particular, it looks for the co-operation of State Labour Departments—and their statistical and research officers. In that way, it is reckoned, practical results will be obtained without setting up a new and unwieldy bureaucratic organisation.

At a conference in London last week, the President of the Board of Trade and Mr. Tomlinson, the Parliamentary Secretary to the Ministry of Labour and National Service, discussed with representatives of employers and operatives in the textile and finishing trades the application of the concentration of production policy to these industries. The President, it is stated, emphasised, firstly, that it was desirable that concentration of production should proceed, so far as possible, by arrangements made between individual firms in the industry, and, secondly, that these arrangements should be submitted as soon as possible, and, in any case, not later than June 10. It was agreed that, except in the case of woollen finishing, where the position is still under consideration, the Cotton Board should assist generally in the preparation of schemes and furnish guidance on the degree of concentration required.

In his speech at the luncheon of the Institution of Civil Engineers, other points in which are reported on page 373, Lord Reith, Minister of Works and Buildings, said that one of the achievements of his department had been the substitution for the old priority system, with all its inconsistencies, of a system of allocation to Departments in terms of labour. Whereas, building proposals had previously reached a peak far in excess of what the industry could meet, they had now secured, after much negotiation, a reduction to the real capacity of the country. The allocation system was now in operation. The more urgent construction works would be so manned as to ensure their speedy completion. Unnecessary building, unnecessary demolition and clearance and extravagant reconstruction were being controlled by the Ministry. Licences for building by private interests were compulsory and not easily secured, for the spending of 100*l.* on any building in twelve months. It might be necessary, Lord Reith added, to reduce that figure still further.

The executive committee of the Mineworkers' Federation decided at a meeting held last week to call a special national delegate conference to discuss the application of the Essential Work Order to the coal-mining industry. The conference took place yesterday. At the time this issue of ENGINEERING went to press, no official information regarding its decisions was available; but, according to the *Daily Herald*, Mr. Lawther, the President of the Federation, stated after last week's meeting of the executive committee, that the chief complaint of the mine workers was that there was no provision in the draft Order for a national wages board. "There is," he is reported to have added, "deep resentment in the executive over the fact that, while provision is being made for owners to have price increases to meet exigencies that may arise from the Order, no provision is made for the miners to meet the low wages prevailing in some districts."

A Bill introduced in the Dail and circulated on Thursday night last, proposes to licence bodies carrying on negotiations with the object of fixing wage rates and working conditions in Eire. Under the new legislation, employers will be obliged to form themselves into unions and be registered, and the organisation of the unions of both employers and employees will be controlled by a tribunal which it is proposed to set up.

Writing in the May issue of the Transport and General Workers' *Record*, Mr. Arthur Deakin, the acting general secretary of the organisation, says:—"Having made up our mind that the democratic way of life is the only acceptable form of government worth having, it is necessary to make an examination of our future policy and development. Unfortunately, there is rather a tendency to regard war-time conditions as a reason why we cannot do forward thinking or planning, and to regard present needs as sufficient unto the day thereof without realising that war time also provides an opportunity to develop our citizenship and all the responsibilities which are involved. The realisation of the ordinary man in the street that all wars have an economic basis, that Naziism and other forms of dictatorship are only possible when a nation or nations are circumscribed economically points very clearly to the need for an immediate study of the problems which will assuredly arise with the advent of peace—and in the interim period."

The recent strike of meat porters in the London area was, as it deserved to be, short-lived, because it was unofficial and was over a difference which could have been adjusted quickly if reasonable men had been in charge of the negotiations. As the public were given to understand, it was concerned with the interpretation of an agreement or agreements. The disturbing feature of the business is that some interests are not averse from pressing their point of view by denying essential food to people who have nothing to do with their trouble. The incident, moreover, comes rather inappropriately at a moment when revision of the Trade Disputes and Trade Union Act is under consideration.

The General Council of the Trades Union Congress, it is announced, have noted with appreciation the recent statement of the Minister of Health regarding the setting up of rehabilitation arrangements wider in scope than those which have hitherto existed. They regret, however, that there are still needless distinctions between different types of casualties which are, they believe, bound to lead to confusion.

EXPORT CONTROL OF TOOLS.—Under a Board of Trade Order (S.R. & O. 1941, No. 592), which comes into force on May 14, 1941, licences will be required to export, to all destinations, certain engineers' small tools, parts and accessories of machine tools and machine-tool jigs.

500-H.P. DIESEL-ELECTRIC LOCOMOTIVE.

IN our issue of January 26, 1940, we described a 550-h.p. electric battery locomotive which was one of six that had been put into commission by the London Passenger Transport Board for the transport of material in connection with the extension of the system and for general shunting purposes. Though the first of these duties has had to be given up temporarily owing to the war, the second is, and must remain, a permanent feature of day-to-day operation. A good deal of this work has to be undertaken during the middle of the night, when the conductor rails are "dead" for inspection purposes or where for other reasons power from the central source is not available. This work has so far been effected by steam locomotives, but these are obviously not altogether suitable for use on the underground sections. Experiments are, therefore, being made with a Diesel-electric locomotive and if the results obtained with this are satisfactory we understand that locomotives of this type will be built after the war to replace the steam locomotives as they wear out.

The first of these Diesel-electric locomotives, which has recently been placed in commission, is illustrated in Fig. 1, on the opposite page. It is interesting from the fact that it has been built in the shops of the London Passenger Transport Board from two old Central London line motor cars. In fact, the only new parts are the engine and its generator, together with some of the switchgear. It is designed for operation either from this set or from the 600-volt conductor rails, and to haul trains of 600 tons on the level or of half that weight up a gradient of 1 in 34. Owing to the limitations imposed by the tube loading gauge, a well type underframe is used to carry the engine and generator. This frame forms the centre of the unit. As has already been said, the end portions of the frame, which carry the equipment compartments and driver's cabs, and are mounted on the bogies, were taken from two old Central London line motor cars. The passenger compartments of these cars were cut out and the central portion joined in to form the new vehicle. The roof panels over the engine compartment and the side louvres and windows are removable so that easy access is obtainable to the engine, generator and equipment, As will be seen, the locomotive can be controlled from either end. In its finished state the locomotive measures 57 ft. 0½ in. over the buffers, the maximum width being 8 ft. 2 in. The maximum height over the roof panels is 9 ft. 4½ in., the wheel diameter 36 in., and the tare weight in running order 62 tons 12 cwt.

As regards the power unit, the engine is of the Petter super-scavenge, airless-injection, two-stroke, cold-starting type, and is shown in position in Fig. 2, opposite. It has six cylinders with an 8¼-in. bore and 13-in. stroke, and is capable of developing 506 brake horse-power at a speed of 675 r.p.m. It can carry an overload of 640 brake horse-power at a speed of 675 r.p.m. for seven minutes. The engine crankcase is extended to accommodate the generator feet, the unit being arranged on a three-point mounting in order to avoid the danger of distortion due to flexing of the underframe. The governor is arranged for two separate speed settings of 460 r.p.m. and 675 r.p.m., the former being the idling speed of the engine. The increase of engine speed from 460 r.p.m. to 675 r.p.m. is effected by means of a spring-loaded. air-operated piston. This is supplied with air through an electro-pneumatic valve, regulation being effected from master controllers in the driver's cabs. The scavenging air is supplied by a blower of the positive displacement type. This is driven from the engine crankshaft and is fitted with an air filter and silencer. The circulating water and lubricating oil are cooled by a pair of radiators, one being mounted on each side of the locomotive. The fans are arranged to draw air through louvres in the engine compartment and to discharge it outwards through the radiators. The fans are driven by a Vee-belt from a cross-shaft, which is, in turn, driven from an extension of the generator armature shaft. A forced-feed lubrication system is employed.

The engine is started by means of compressed air at a pressure of approximately 350 lb. per square inch. The apparatus consists of starting gear on the engine and one storage receiver, the latter being charged through a reducing valve from two high-pressure cylinders, which are charged to 1,800 lb. per square inch. A number of safety devices are fitted to guard against damage to the engine and these include a lubricating oil pressure switch and an overspeed cut-out. The generator, which was constructed by the Brush Electrical Engineering Company, Limited, Loughborough, is of the level compounded type and is designed to supply 750 amperes continuously at a pressure of 450 volts at a speed of 675 r.p.m., its temperature rise being in accordance with British Standard Specification 173 for Class B insulation. The armature is carried in one self-aligning roller bearing. It is provided at the opposite end with a Wellman-Bibby coupling.

DIESEL-ELECTRIC LOCOMOTIVE FOR THE L.P.T.B.

FIG. 1.

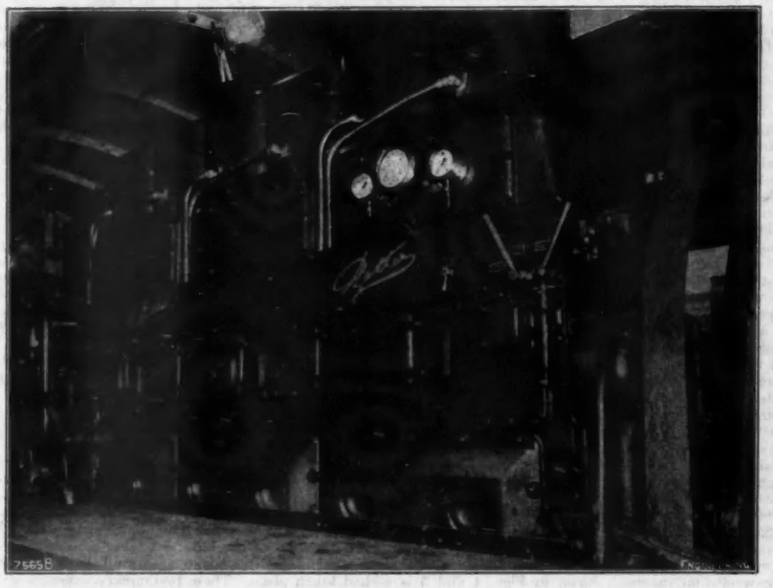


FIG. 2.

As has already been mentioned, the electrical equipment is arranged to operate either from power obtained from the conductor rail or from the Diesel-electric set at 450 volts. The change-over from one to the other is made by a drum switch, which can only be operated after it has been unlocked by the driver's reversing key. This ensures that no power current shall be broken at the switch contacts. The locomotive is fitted with two series-parallel equipments with automatic relay controlled notching. These equipments are housed in the two end compartments. The master controller has three positions: shunting notch, series and parallel. When operating from the line, the equipments function in the normal manner and provision is made for cutting out either should it become defective. Owing to the limited maximum output of the Diesel-generator set, it was not possible to notch up the two equipments in parallel. The control is, therefore, modified so that when changing from full series to parallel, one equipment drops out while the other notches up in parallel. This condition is maintained until the leading equipment has reached full parallel and the current demand has fallen to half the maximum permissible output of the generator. A relay then operates which brings in the second equipment and this is also notched up into full parallel.

As already stated, a large part of the traction and control equipment was originally in use on the two motor cars from which the locomotive was constructed. A number of special relays, a main change-over switch and a separate main circuit breaker to protect the generator have been added. The new equipment and the modifications were made by The British Thomson-Houston Company, Limited, Rugby.

THE DIRECT PRODUCTION OF MAGNESIUM.

EXTENSIVE laboratory experiments conducted by metallurgists of the U.S. Bureau of Mines with the object of producing magnesium metal from magnesite ore by direct methods are stated by Dr. R. R. Sayers, the Director of the Bureau, to have proved sufficiently encouraging to warrant trying out the process on an engineering scale. The experiments were commenced some five years ago, in active co-operation with the State College of Washington, at Pullman, and owed their inception to the fact that, side by side with large deposits of high-grade magnesite worked to provide material for the refractories industry, there exist, in the State of Washington, considerable resources of low-grade mineral for which, at one time, there appeared to be no immediate industrial use. A survey of the possibilities of producing magnesium metal from these deposits was made in the early stages of the investigation, and experiments were undertaken to prepare anhydrous magnesium chloride which could be used in the production of the metal by the established commercial process, involving the electrolysis of the chloride in a fused salt bath. At length, however, the Bureau studied the possibilities of the direct production of the metal from the ore by reduction with carbon, the resultant magnesium and carbon monoxide vapours being chilled in an atmosphere of hydrogen to prevent re-oxidation. As hydrogen is a relatively expensive gas and large volumes are necessary to cool small quantities of magnesium metal vapour, and since, moreover, the use of hydrogen entails the possibility of explosions, the Bureau undertook to develop a new method of chilling the vapour.

Early experiments in the laboratory at Pullman indicated that a spray of a hydrocarbon oil could be substituted for the hydrogen. Laboratory tests gave encouraging results, and, with funds provided by Congress, a small pilot plant to carry on the investigations on a somewhat larger scale has been constructed at Pullman. Furthermore, a successful method of concentrating the low-grade magnesites by flotation has been developed. The new pilot plant is designed for the daily production of from 50 lb. to 100 lb. of the metal by the electro-thermic method. In conclusion, it may be of interest to note that the commercial manufacture of magnesium in the United States did not commence until 1915, when production totalled 39 tons. The output reached 127 tons in 1918, but fell off afterwards. About 1925, however, the demand again gradually began to increase, until the sales of the metal totalled 640 tons in 1933 and thereafter rose rapidly to a record high level of consumption of 5,580 tons in 1940.

THE FORMATION AND PROPERTIES OF MARTENSITE ON THE SURFACE OF ROPE WIRE.*

By E. M. TRENT, M.Met., Ph.D.

WIRE ropes used in mining, in particular haulage ropes, are frequently subject to severe wear in service. This wear, by reducing the cross-sectional area of the outer wires, gradually reduces the strength of the rope. A more serious effect where severe wear takes place is the formation of a brittle surface on the wire. Cracks are formed in this brittle surface and these can lead to the rapid failure of the outer wires before they have been seriously reduced in cross-section. This type of deterioration is more difficult to detect by inspection, and is therefore more dangerous. In a recent case examined by the Safety in Mines Research Board a haulage rope failed after only six months' service. Examination on the day before failure had revealed no defect. Investigation after failure showed that the outer wires had been reduced in diameter by only 11 per cent., while the general recommendation of the Safety in Mines Research Board, with regard to wear, is that a round strand rope becomes unsafe and "should not be allowed to remain in service after 40 per cent. of the thickness of the outer wires has been worn away at the worst point."

In this case the deterioration had been caused by the formation of a brittle layer on the worn surface. Examination of sections of the wires under the microscope showed the presence of a layer of martensite, of maximum thickness approximately 0·003 in., covering a large area of the worn surface. Cracks formed in this martensitic layer, which was very brittle, caused the failure of 20 out of the 36 outer wires in the rope at the point of fracture. The presence of such martensitic layers, caused by a rapid heating and cooling of the immediate surface of the wires during friction, has been known for some time. It was described by Atkins in a paper to the Iron and Steel Institute in 1927, and a more detailed description is given in the Thirteenth Annual Report of the Safety in Mines Research Board, 1934. The importance of these martensitic layers as a factor in the deterioration of wire ropes, however, has been under-estimated. The following figures indicate the frequency with which martensite occurs and its importance as a cause of failure in mining haulage ropes. Of the last 35 haulage-rope breakages examined by the Safety in Mines Research Board, two were capel failures. Of the remaining thirty-three, twenty-four, or 72 per cent., showed the presence of a layer of martensite on the worn surfaces, while in the case of thirteen, or 39 per cent., the martensite was definitely an important contributory cause of failure. Because of its importance in this respect, further investigations into the mechanism of the formation and the properties of the martensitic layers were carried out.

Structure of the Martensitic Layers.—The area covered by any one layer of martensite on the worn surface is comparatively small and in the form of a narrow strip. This strip extends along the worn surface of the wire in the direction of rubbing, that is, in the direction of the axis of the rope. In the case of a Lang-lay rope, the strip extends diagonally across the worn surface of the wire. If the worn surface is polished and etched, the strips of martensite show up white against a dark background. When the wire is sectioned through the worn surface, polished and etched in 1 per cent. nitric acid in alcohol, the martensite appears as a white or slightly-yellow structureless layer sharply separated from the sorbite of the normal wire (Fig. 1, Plate XXIX). This layer normally varies in thickness from approximately 0·0001 in. to 0·0035 in. In cross-section the strips are lenticular in shape, being thickest towards the centre and decreasing in thickness towards the sides, the total width of the strip being usually not more than 0·03 in. The small size of the martensite areas indicates that the area of contact between the wire and the rubbing agent is very small and thus the local pressure may be very high.

In many cases the wire surface has been subjected to friction a great many times. The layers of martensite formed frequently overlap, and a typical structure is seen in Fig. 2, Plate XXIX. This is a longitudinal section through the worn surface of a wire. The first layer of martensite that was formed is the white area farthest to the right in the micrograph; it originally covered almost the whole area of the surface shown here in section, and it gradually decreased in thickness towards the right. The second layer was caused by further friction on the surface already covered with martensite; this is the white area towards the left of the micrograph. The two layers are separated by a dark band; this was the result of a tempering of the first layer of martensite, which, at this point, was reheated by the friction to a temperature below 700 deg. C. In some cases several layers of martensite are produced one on top of the other, the last layer formed in each case tempering the layer immediately preceding it, so that the layers are separated by dark bands.

The temperature gradient in the wire caused by the friction is undoubtedly very steep. A rough estimation of the steepness of this gradient can be made from the tempered layers described above. These tempered zones are usually not more than 0·002 in. thick. Supposing that the minimum temperature required to form martensite is 700 deg. C. and the minimum temperature to cause a visible darkening of the martensite is 400 deg. C., then there is a temperature gradient of 150 deg. C. per 0·001 in. of the tempered martensite. It is possible that a higher temperature than 400 deg. C. might be required to produce a visible darkening of the martensite, owing to the extremely short time of tempering, but the figure given above may be regarded as a rough estimate. It may be assumed that the temperature gradient is at least as steep in the martensite—*i.e.*, in that depth of the steel that was converted to austenite—so that in a layer of martensite 0·003 in. thick it is probable that the surface reached a temperature of at least 1,150 deg. C.

The heating and cooling of the surface layer must take place in a very short space of time—a matter of a few seconds if not less. The transformation, on heating, from sorbite to austenite must proceed very rapidly, and this is facilitated by the fact that in rope wire the carbide is very finely dispersed. The structure of the sorbite is either not resolvable or only just resolvable at a magnification of 1,000 diameters. A coarser structure would require either a longer time or a higher temperature for the complete transformation to austenite. Where there are ferrite streaks at the grain boundaries of the steel, these are frequently not dissolved into the austenite on heating, and are visible in the martensite. This is probably due to the fact that, although they are thin, these streaks of ferrite are many times thicker than the cementite laminæ of the sorbite, and hence would take longer to dissolve. The very rapid cooling of the surface layer is due to the continuous contact of the very thin heated layer with the main body of the wire, which remains cold; the cooling is mainly due to conduction through the wire.

The martensite etches either white or slightly yellow in colour, depending on the time of etching, but no acicular structure is developed, probably because of the extremely small grain size produced by the rapid heating and cooling. When a layer of martensite is subjected to a second period of friction, the very small grain size and the even finer distribution of the carbide again facilitate its rapid transformation to austenite, while the martensite which is reheated to a temperature below the critical point is tempered, with the precipitation of very finely dispersed carbide particles. This finely dispersed carbide etches very rapidly in 1 per cent. nitric acid in alcohol, quickly becoming jet black.

So far, only martensitic layers formed from the steel of the wire itself have been considered. This is the main cause of surface brittleness in wires from haulage ropes. If the worn surfaces of the wires are examined at a low magnification they are frequently seen to be rough, as if there had been actual seizing of the wire on to the object against which it was rubbing. If a wire is sectioned through these rough areas, the extreme outer layer of the martensite is seen to be by no means homogeneous; see Figs. 3, 4 and 5, Plate XXIX. At least a part of this material is apparently iron or steel which was welded on to the wire from the surface against which the wire was rubbing under conditions of high pressure and temperature. These welded-on layers are usually extremely thin in haulage ropes (less than 0·0005 in.) and for this reason the structures are difficult to interpret. Further consideration will be given to these structures in the section on experimental work below; from the latter it was concluded that the welded-on material shown in Figs. 4 and 5 is a fairly high-carbon steel or cast iron, while that shown in Fig. 3 is probably mild steel or wrought iron.

On the worn surfaces of two winding ropes, much heavier layers of extraneous material were found welded on to the wire. Fig. 6 is a section through the surface layers of one of these. The extraneous material here consists of ferrite with numerous slag particles, welded on to a partially tempered layer of martensite formed from the steel of the wire. The welded-on material is probably either wrought iron or the surface layers of a weld. In the second case, the welded-on material was obviously a mild steel. It had been welded on to the wire from a mild-steel plug in a capel, against which the wire seized when the rope failed at the capel. Examination of the plug showed that its surface layers also had been heated to a high temperature and that thin flakes of martensitic steel (0·0005 in. thick) from the wire had been welded on to the plug in some places.

It is thus demonstrated that, under the conditions of friction found in service, the rope can seize or weld locally on to the object against which it is rubbing. When such welding takes place, the welded materials subsequently break apart, either (*a*) at the weld, or (*b*) by tearing away portions of the wire or the other object. Which of these occurs depends on the strength of the weld (*i.e.*, on the temperature and pressure of welding, etc.) or on the strength of the two materials and the presence in them of cracks or other sources of weakness. In any case, this must lead to rapid wear of the object against which the rope is rubbing, and probably also of the rope itself. Where such seizing occurs the coefficient of friction will greatly increase, and consequently the heat generated will also be much greater and martensite is more likely to be formed.

The Cracking of Martensitic Layers.—The thin layers of martensite on the surface of the wire are very brittle and can withstand very little, if any, plastic deformation. Thus it is usual to find that the martensite produced on rope wires in service contains numerous cracks. Two cracks are seen in Fig. 2 and one in Fig. 4. An examination of the worn surfaces at a low magnification frequently reveals a whole series of cracks running across the wire. Once a crack is formed in the martensite it acts as a stress-raiser. The bending stress induced in the wire—for instance, when the rope passes over a pulley—is concentrated at the base of the crack, which is rapidly deepened by fatigue until the wire breaks. The wire illustrated in Fig. 6 thus failed in fatigue, and the micrograph shows a secondary fatigue crack starting from the martensite. In wires that have been fractured by a single application of a bending stress at a cross-section containing an embrittled surface, it is frequently found that the fracture started from a crack in the worn surface and proceeded for a certain distance in shear. Thus a crack in a martensitic layer constitutes an important source of weakness in rope wire.

These cracks are most frequently found at or near a point where a layer of martensite has been reheated by the overlapping of a second layer, as in the case of the two cracks shown in Fig. 2. The stresses set up by the heavy pressure and friction and those caused by the steep temperature gradients involved are probably the cause of the cracking of the martensite in most cases. It is possible that the pressure of the rope on the object against which it is rubbing, by causing a local bending of the wire, would itself be sufficient to propagate the cracks into the sorbite. Thus, sufficiently high rubbing stresses may, by themselves, cause failure, even though the actual loading stresses on the rope are safe and the pulley diameters sufficiently large.

The cracks found in martensite are not always normal to the wire surface, but are often bent over, as shown in Fig. 4. Here the crack was originally formed in a direction normal to the surface in the first layer of martensite. It was then bent over to the left by the dragging of the metal involved in the formation of the second layer. The crack was finally covered over by the layer of welded-on material, so that it does not reach the surface of the wire. This bending-over of the crack was possible because, during the time of friction, this layer of the metal was austenitic and at a temperature of over 700 deg. C. and hence was highly plastic. In this case it is obvious that the direction of friction has been from right to left. In Fig. 7, Plate XXIX, the crack has been dragged by friction in both directions, indicating that the friction occurred while the rope was travelling both to the left and to the right.

Experimental Work: Laboratory Production of Martensitic Layers.—In one rope, a wire which had been damaged by a blow from a sharp object, such as a chisel, was found to have a layer of martensite on the cut surface. Wire cut by hand clippers sometimes had a layer of martensite on the clipped end. It was found that on crushing a wire on an anvil by means of a blow with a heavy hammer, the wire tended to split longitudinally on a plane at approximately 45 deg. to the direction of the blow. A layer of martensite was formed along this plane when sufficient deformation had taken place. These preliminary experiments suggested the possibility of reproducing in the laboratory the martensitic layers on the wire surface by striking the wire a glancing blow.

The wire used for these experiments was of "plough steel" grade—a grade of hard-drawn, sorbitic wire of a type used for wire ropes. The wire was 0·1 in. in diameter, with a tensile strength of 109 tons per square inch. In the reverse-bend test over a 5-mm. radius, it required nine or ten bends through 180 deg. to fracture it. The number of twists to failure in the torsion test was 41 over a length of 100 diameters. The composition of the wire was as follows:—

Carbon.	Manganese.	Silicon.	Sulphur.	Phosphorus.
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
0·61	0·70	0·112	0·035	0·042

An attachment was made by which a hardened steel tool, rounded at the end, was fastened to the pendulum of an Izod impact testing machine. The wire was held by means of a special grip in the vice of the machine;

* Investigation carried out as part of the work of the Safety in Mines Research Board on Wire Ropes, presented, for written discussion, to the Iron and Steel Institute. Abridged.

MARTENSITE ON MINING HAULAGE-ROPE WIRE.

(*For Description, see Page* 378).

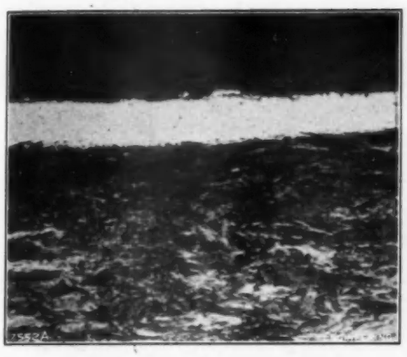


FIG. 1. SECTION THROUGH MARTENSITIC LAYER. × 200.

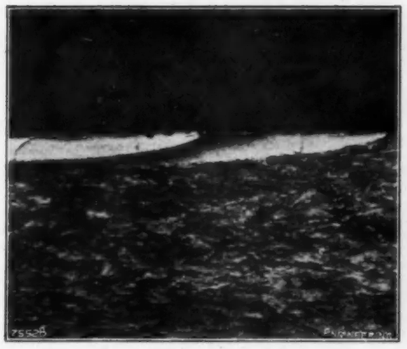


FIG. 2. TWO MARTENSITIC LAYERS OVERLAPPING. × 150.

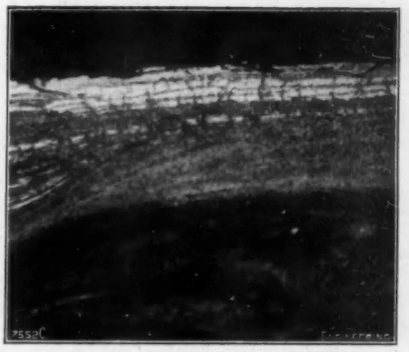


FIG. 3. MARTENSITIC LAYER WITH EXTRANEOUS MATERIAL WELDED ON. × 500.

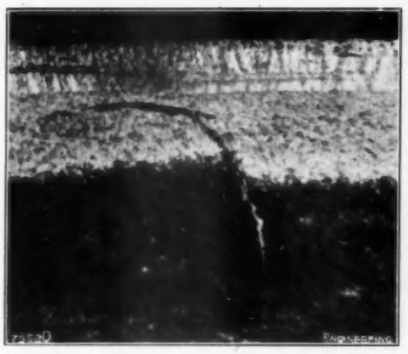


FIG. 4. AS IN FIG. 3, SHOWING CRACK IN MARTENSITE. × 600.

FIG. 5. AS IN FIG. 3 AT HIGHER MAGNIFICATION. × 1000.

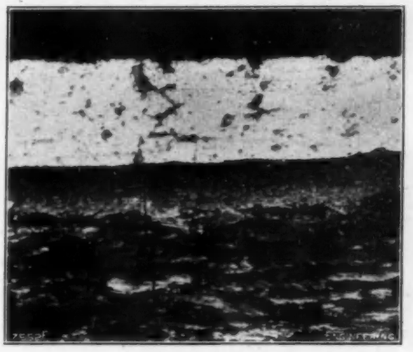


FIG. 6. AS IN FIG. 3, SHOWING FATIGUE CRACK. × 200.

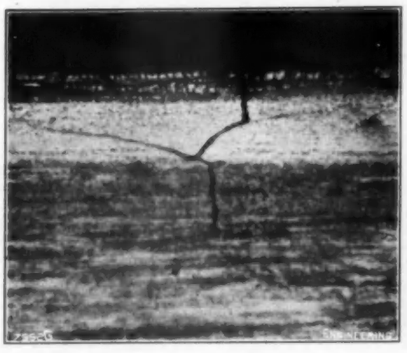


FIG. 7. CRACK IN MARTENSITIC LAYER. × 500.

FIG. 8. MARTENSITE AND AUSTENITE-MARTENSITE LAYERS PRODUCED ON WIRE IN LABORATORY. × 500.

FIG. 9. AS IN FIG. 8, WITH FATIGUE CRACK. × 500.

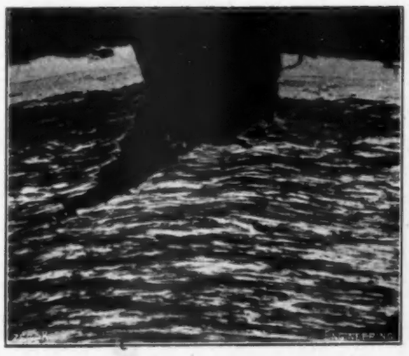


FIG. 10. CRACK STARTING IN MARTENSITE, PRODUCED BY TWO REVERSED BENDS. × 150.

FIG. 11. CRACKS STARTING IN MARTENSITE PRODUCED BY 12 BENDS THROUGH 20 DEG. × 150.

FIG. 12. MARTENSITE PRODUCED IN LABORATORY BY RUBBING. × 500.

(*To face page* 378.)

UNIV. OF MICH.

CORROSION PITTING ON WORN WIRE ROPES.

FIG. 13. CRACK IN MARTENSITE. × 500.

FIG. 14. AS IN FIG. 13 AFTER 6 HOURS IN 1 PER CENT. SULPHURIC ACID. × 500.

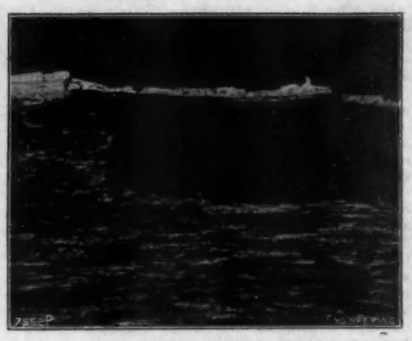


FIG. 15. AS IN FIG. 13, AFTER 14 HOURS IN 1 PER CENT. SULPHURIC ACID. × 200.

the axis of the wire was in the plane of swing of the pendulum and the wire was slightly bowed. The tool thus struck the wire a glancing blow and the energy absorbed was measured in foot-pounds on the scale of the Izod machine. It was found that when the energy absorbed was below 8 ft.-lb., no martensite was formed and the surface was merely scored. When the tool was lowered so that a deeper "cut" was taken, the wire was very little scored and a layer of martensite was formed, which increased in thickness as the energy absorbed increased. The tool was deeply nicked by the blow and that part of the wire on which martensite was found had increased in diameter by 0·001 in. This suggested that material from the tool had been welded on to the wire. This was confirmed by weighing the tool and the wire before and after the operation. The wire gained 0·0021 g. in weight while the tool lost 0·0039 g. on the average.

Micro-examination revealed two layers in the martensite, the outer layer being formed from the tool and the inner one from the steel of the wire (Fig. 8, Plate XXIX). The inner layer consisted of the normal slightly yellow-coloured martensite. The outer layer was much whiter, but had brown irregular markings running vertically through it. It was found that where the outer layer was cold-worked after the formation of martensite, as, for instance, where the wire was cut with clippers, the brown markings became an interlacing network of lines and the whole of the outer layer etched a yellow-brown colour. Several of the wires were tested in fatigue, and Fig. 9 shows a fatigue crack starting from the martensite. Where the fatigue crack passes through the outer layer, this layer has been cold-worked and the brown markings have become a mass of interlacing lines. Under high magnification these brown markings are seen to be a series of very fine needles. This microscopical evidence indicates that the majority of the outer layer at first consisted of austenite (which etched white), with a few series of needles of martensite. The application of cold-work rapidly converted this austenite to martensite. The tool from which the austenite layer was formed was made from a plain carbon tool steel containing approximately 1·2 per cent. of carbon. The retention of so much austenite in a plain carbon steel is most unusual and must have been caused by the exceptionally rapid cooling of this very thin layer.

These structures very closely resemble the structures described above which are found in the outer layers of martensite on some rope wires from service (compare the structures in Figs. 8 and 9 with those in Figs. 4 and 5, Plate XXIX). In Fig. 4, the material above the crack has apparently been cold-worked and transformed entirely to martensite. In these cases the layers are thinner and it is not possible to show up the needle structure of the martensite formed in the austenite. It must be deduced from these structures that the rope had been rubbing against some steel high in carbon, or a cast iron.

The martensitic layers produced in the laboratory were easily cracked by bending the wire through a small angle, *e.g.*, through an angle of 20 deg. over a radius of approximately ¼ in. In the reverse-bend test over a 5-mm. radius, a wire with martensite on the surface broke after seven bends, while a wire without martensite withstood nine or ten bends. Cracks were formed during the first bend, and Fig. 10 shows the crack formed after two bends. In this severe test the fracture was propagated mainly by shear, with large tears accompanying each bend to produce a very rough fracture. Fig. 11 illustrates some of the cracks produced by 12 bends through approximately 20 deg. over a 5-mm. radius. With this small angle of bend the cracks produced were much more smooth and more like fatigue cracks, the amount of tearing accompanying each bend being much smaller. Under these conditions a wire with a layer of martensite contained a crack penetrating to one-third of the diameter after 12 bends, while a wire without martensite required 45 bends to produce the same result.

It has not been possible to carry out a full series of fatigue tests for the comparison of wires with and without martensitic coatings. This is because, in producing the martensite coating as described above, the tool slightly nicks the wire at the point where it first comes in contact with the wire. The wires tend to fail at this damaged part, and thus the results of the fatigue tests cannot be regarded as demonstrating conclusively the effects of martensite on the fatigue properties of the wire. The results, however, indicate that a martensitic coating, starting without cracks, has little influence on the fatigue limit or on the number of reversals to failure up to a stress of approximately 45 tons per square inch. This might be expected, since the tensile strength of martensite is certainly not lower than that of the sorbite of the drawn wire. However, if the martensite were cracked before the test, it would be expected that the fatigue limit would be greatly lowered, since these cracks would act as stress raisers. Also, if the reversed stress were raised to a point where the plastic deformation of the wire itself was comparatively large, the martensite, being unable to deform plastically, would be cracked during the first few reversals of stress and the wire would fail rapidly. Thus one would expect that when the stress was raised above a certain point the wires with a martensitic coating would prove themselves markedly inferior to the normal wire. Such a tendency is indicated by the result of the reverse-bend test through a small angle described above. The martensitic coating appeared to have little effect on the tensile strength or on the torsion-test results.

The above method of forming martensite by means of a rapid glancing blow probably does not correspond closely to the conditions under which it is formed in rope wire; here the martensite is formed by a slower friction with heavy pressure. In order to reproduce these conditions a wire was fixed to the travelling table of a planing machine, and was worn by lowering on to it a tool with a rounded end. At first a tool tipped with a polished piece of tungsten carbide was used. The wire was very rapidly worn, a polished surface being produced, while the tool itself was not marked. The worn surface, however, was not excessively brittle, and no martensite could be detected under the microscope. A layer of martensite was produced, however, by first wearing the wire with a tungsten-carbide tool to produce a flat surface, and then wearing it with a hardened steel tool, which tore and roughened the surface to some extent, although the tool itself was hardly marked. From the appearance of the wire and the tool it seems that some seizing took place, which did not occur with the tungsten-carbide tool. Fig. 12, Plate XXIX, shows a section through the martensite thus produced. The speed of travel of the wire relative to the tool was approximately 0·4 ft. per second, which is less than one-tenth of the maximum speed of a haulage rope in service.

Discussion.—The work of Bowden and his co-workers* has shown that during friction there is a considerable rise in temperature at the interface. For pairs of metals such as lead and steel, Wood's metal and steel, constantan and steel, etc., it was found that the surface temperature achieved was directly proportional to the relative velocity of the two surfaces and to the load, until the melting point of the lower-melting metal was reached, after which no increase in surface temperature occurred. It was also found that in most cases the sliding of one metal over the other took place in jerks, the surface sticking together, then slipping a short distance, then sticking again. The coefficient of friction was found to attain very high values when two similar metals were rubbed together, and in this case seizing readily occurred and both surfaces were torn. The present work on martensite is in agreement with these results. Since the pressures associated with the wear of haulage ropes are much greater than those used by Bowden, one would expect to find higher surface temperatures than those recorded in his work; also the depth of the high-temperature zone is much greater. The seizing of the wire with the object against which it was rubbing is also in agreement with the process of sliding as described by Bowden, but, once again, the pressure being much higher, the actual area of seizing, or welding-together, is probably considerably greater.

Since the quantity of heat liberated during friction is proportional to the coefficient of friction, and since the coefficient of friction is highest for two similar metals, one would expect martensite to be formed most readily when steel rubbed against steel. As described above, when a wire was rubbed with a tungsten-carbide tool, no visible layer of martensite was formed, while a heavy layer was produced with a hardened carbon-steel tool. The higher coefficient of friction and the high surface temperatures attained between two similar metals are undoubtedly associated with the fact that seizure and welding would occur more readily between two similar than between two dissimilar metals.

Corrosion Pitting on Worn Surfaces of Haulage Ropes.—A distinctive form of corrosion pitting is sometimes found on the worn surfaces of haulage ropes. This takes the form of chains of pits running down the centre of the worn surface. It was noticed that this pitting was frequently associated with the presence of martensite. Examination of the pitted surface at low magnification after polishing and etching revealed in nearly every case layers of martensite on the unpitted part of the surface with cracks running into the pits. Micro-examination of sections through the pitted surface showed that in many cases the corrosion pits undermined the martensitic surface. This suggested that the pitting might be caused by a localisation of corrosion at the cracks in the martensite. It is difficult to prove this by the examination of pitted wires, since the process of pitting proceeds simultaneously with the processes of wear and martensite formation, so that evidence of the original cracks from which the pits were formed is destroyed in the process. However, the presence of cracks and the undermining of the martensite by corrosion indicate the probability that this is the cause of pitting.

An attempt was made to reproduce this pitting in the laboratory. Wires coated with martensite by striking a glancing blow, as described above, were bent so as to crack the martensite. The wires were then immersed in a 1 per cent. solution of sulphuric acid for various periods of time at room temperature (approximately 20 deg. C.). After 6 hours small areas of the martensite between the cracks began to flake off, being completely undermined by corrosion. After 14 hours, comparatively large areas of martensite had flaked off, exposing corrosion pits of considerable depth. Figs. 13 to 15, on this page, show the progress of

* F. P. Bowden and K. E. W. Ridler, *Proc. Royal Soc.*, vol. 154, page 640 (1936), and F. P. Bowden and D. Tabor, *Proc. Royal Soc.*, vol. 169, page 391 (1939).

corrosion. Fig. 13 illustrates a crack in the martensite before corrosion. After 2 hours in 1 per cent. sulphuric acid, the crack was found to have widened and a pit formed in the sorbite below the martensite. Fig. 14, taken after 6 hours corrosion, reveals a considerable deepening and extension of the pit, so that it undermines a much greater area of the martensite. Fig. 15 shows a deep pit formed after 14 hours corrosion, with some flakes of martensite still remaining above it.

Although these tests deal only with one corrosive medium, they show that corrosion pits can be formed owing to cracks in the martensitic surface. This pitting may be due either to an electrochemical effect caused by a difference in potential between the martensite and the sorbite (enhanced in this case by the fact that the outer layer of the martensite was of a different composition from that of the wire itself) or to differential aeration, causing localisation of corrosion at the base of the crack. In the latter case it would be expected that corrosion would occur at any crack in the steel, whether martensite were present or not. There is some indication that this may be so, but in any case the importance of martensite in causing pitting is not diminished, since the presence of martensite seems to be the main cause of cracking of the worn surface.

Conclusions.—The formation of martensite on rope wire is an important cause of deterioration and failure in haulage ropes and can also contribute to the deterioration of winding ropes. The presence of martensite on the worn surfaces of the wires may lead to rapid failure of the rope by fatigue before inspection reveals that the rope is in a dangerous condition. Care should be taken to prevent the rope from rubbing against any metal object. In rubbing against such objects the rope wire may seize on to them, and this leads to the rapid wear both of the rope and of the object against which it is rubbing. Thin layers of metal may be welded on to the rope wire, owing to the high pressure and temperatures during friction, and microscopical examination may be able to give an indication of the nature of the material against which the rope was rubbing. Under certain conditions of corrosion the presence of martensite containing cracks leads to the formation of corrosion pits on the worn surface of wire.

HIGH-SPEED BAND SAW.

An interesting application of synthetic plastic material in engineering practice occurs in a band saw recently developed by Messrs. Boice-Crane Company, Toledo, Ohio, U.S.A., who are represented in Great Britain by Messrs. Broadway Engineering Company, Limited, Carlisle-road, Hendon, London, N.W.9. The wheels over which the saw runs are of moulded Bakelite, and are of the disc type, 14 in. in diameter by 1 in. wide on the face. The weight per wheel is 2¼ lb. It is claimed that this light-weight construction enables the wheels to be run safely at speeds up to 1,200 r.p.m., and with increase of life of the spindle ball bearings compared with those of machines of the same size and type having wheels of cast iron, pressed steel or aluminium, most band saws with wheels of one or other of these metals running at about 600 r.p.m. The new machine is motor-driven and is provided with a gear-box for speed variation. A total of eight wheel speeds is available, the highest being 1,120 r.p.m. and the lowest 25 r.p.m., giving blade speeds of about 4,100 ft. per minute and 92 ft. per minute, respectively. At the highest speed with a blade having seven teeth per inch 5,740 teeth pass the cutting point per second. As is well known, however, the tooth pitch and blade speed vary greatly for different classes of work if cutting is to be effective; thus, castings in aluminium alloy may require from 12 teeth to 14 teeth per inch and a blade speed of 100 ft. to 150 ft. per minute, while aluminium sheet may be cut with blades having 8 teeth to 14 teeth per inch and running at from 1,000 ft. to 3,000 ft. per minute. Copper may be cut with a blade pitch of 8 teeth to 12 teeth per in. and a blade speed of from 500 ft. to 1,000 ft. per minute, and structural steel, with a blade pitch of 10 teeth to 14 teeth per inch with a blade speed of 90 ft. to 150 ft. per minute. These figures illustrate the utility of a wide speed range for a band saw.

The saw above referred to is suitable for cutting either metals, fibre or plastic material. Five blade widths ranging from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. are available. The maximum length of blade is 98 in. The frame is of all-welded steel and the driving motor is housed in a separate compartment of the base. The capacity of the saw is indicated by the distance from the cutting strand of the blade to the guard of the return strand, which distance is 13¾ in., and by the maximum distance from the bottom of the blade guide to the top of the work table, which is 8¼ in. The table surface is 15 in. by 15¼ in. and the table can be tilted 45 deg. in one direction and 10 deg. in the other. The wheel guard is provided with a safety device which ensures that, until it is properly closed, the machine cannot be operated.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.
Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARATUS.

529,685. Mercury-Arc Rectifier. The English Electric Company, Limited, of London, H. C. Beck, of Stafford, and B. M. Murray, of Bedford. June 6, 1939.—Hitherto the containers of mercury-arc rectifiers have been of glass or steel. The invention is the use of an aluminium alloy tank, the inner surface of which is anodised to increase its resistance to attack by mercury vapour. This has the particular advantage of rendering the inner surface of the tank substantially electrically non-conducting. An alloy of aluminium and manganese is used containing about 1·25 per cent. of manganese, since this alloy is not attacked by mercury vapour at atmospheric temperatures. Potassium dichromate is forced into the pores of the inner surface of the tank after anodising, to ensure that at the high temperatures obtaining inside the rectifier the pores of the metal do not open and permit attack by the mercury vapour. Such a tank is lighter than a similar steel tank, and has a higher thermal conductivity than glass or steel, so that, on account of the greater ease with which the heat produced can be led away from the rectifier, a considerably greater output can be obtained. The wall of the tank also does not give off appreciable quantities of gas or permit the passage through it of gases from outside. The invention is applicable to permanently sealed pumpless rectifiers as well as to those left permanently connected to a pump, and to water or air-cooled rectifiers. (*Accepted November 26, 1940.*)

FURNACE APPARATUS.

530,648. Travelling-Grate Stoker. Babcock and Wilcox, Limited, of London, and C. H. G. Haywood, of London. (5 *Figs.*) June 16, 1939.—The stoker is of the type in which bars carried between parallel driving chains carry sets of edgewise-mounted bars. The grate bars 8, 8a, mounted on any one bulb bar 7, are intermeshed with the grate bars mounted on the two neighbouring bulb bars, and in the upper run of the grate the ends of corresponding grate bars mounted on alternate bulb bars abut one another. The grate bars are of the drop type and the bars 8 have jaws 9. Short sleeves 11 are arranged close to one another, and are a sliding fit over the bulb bar head. These sleeves are of a size to be embraced with some play by the generally circular eye 12 of the

Fig. 1.

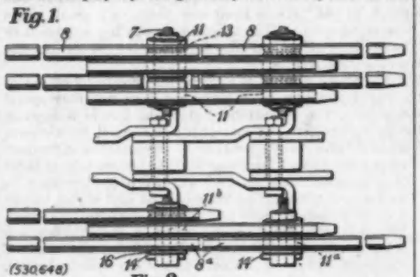
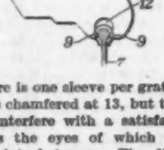


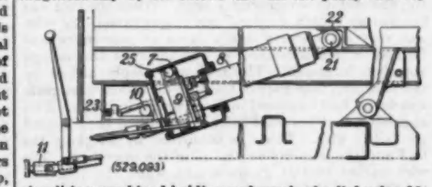
Fig. 2.



grate bars. There is one sleeve per grate bar. The ends of the sleeves are chamfered at 13, but this chamfering is not enough to interfere with a satisfactory seating of those grate bars the eyes of which engage pairs of sleeves at the joints between. The dimensions of the jaws 9, the sleeves 11, and the heads of the bulb bars are such that while a grate bar cannot be lifted as a whole clear of the bulb bar while the jaws embrace a sleeve, it can be removed if no sleeve is within the jaws. The end sleeves 11a on alternate bulb bars are shorter than the sleeves 11 and are held in place by split pins 14 which prevent displacement of the sleeves 11. Also the bars 8a at the margin of the grate which are supported on the other alternate bulb bars have eyes which fit directly over the bulb bar heads. All the bars on one side have plane vertical faces and on the other side they have flats around the edges of the eyes. At the margin of the grate the inner faces of the bars 8a butt against sleeves 11b which are shorter than the sleeves 11, and the flats butt against washers 16 held in place by split pins. A grate bar 8a is removed by withdrawing the associated split pin 14 and washer 16 and sliding the bar off the end of the bulb bar. When a grate bar 8 is to be replaced, the row is brought to the front return bend of the stoker, and the split pin on the associated bulb bar is removed so that the sleeves 11 can slide on the head of the bulb bar. The old bar is then broken and removed and the sleeves on one or both sides are moved until there is a gap between them sufficiently wide for a new grate bar to be slipped over the head of the bulb bar (see Fig. 2), and the sleeves on both sides of the gap are then driven inwards so that they enter the eye 12 of the new grate bar. Finally, the remaining parts being correctly positioned, the split pin is reinserted at the end of the bulb bar. (*Accepted December 17, 1940.*)

MOTOR VEHICLES.

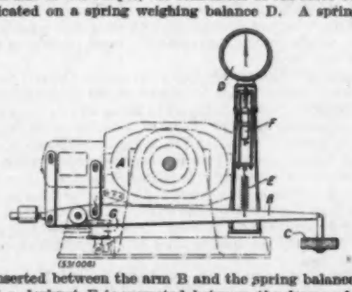
529,093. Lorry Tipping Gear. Wood Hoists, Limited, of Bolton, and R. Houldsworth, of Bolton. (3 *Figs.*) April 12, 1939.—The tipping unit consists of an oil container 7, telescopic ram 8 and pump 9, and is trunnioned on a cross-member of the lorry chassis at 10. The pump 9 is connected to the drive 11 through telescopic shafting and universal joints. The oil container 7 is rectangular and surrounds the end of the outer cylinder of the ram. The telescoping end 21 of the ram is pivoted to the centre cross-member 22 of the body, so as to give a three-point suspension. The trunnion 10 is adjustable longitudinally by set screws 23. In the pump delivery



circuit is a combined holding and overload relief valve 25, whereby, on the pump being stopped at any time during the tipping operation, the body is held until positively released by the operator. The valve functions as a by-pass when the body is fully elevated, say, to 50 deg., and as a holding valve in this or any intermediate position. The pump suction and delivery pipes are completely enclosed, reducing the vulnerability of the unit, while by mounting the ram between the chassis and the body, no parts project below the chassis to foul on rough ground, and there is no upward ram projection behind the driver's cab. (*Accepted November 14, 1940.*)

MISCELLANEOUS.

531,006. Torque-Reaction Dynamometer. Heenan and Froude, Limited, of Worcester, and G. H. Walker, of Worcester. (4 *Figs.*) July 8, 1939.—The dynamometer is of the type in which a swinging carcase is prevented from rotating by being connected to a weighing apparatus by which the value of the torque reaction is measured. The swinging carcase A is connected to an arm B through a lever system so arranged that the apparatus can be used to measure torques exerted in either a clockwise or anti-clockwise direction. From the arm is suspended a number of weights C for balancing a portion of the force due to the torque, the remainder of the force being indicated on a spring weighing balance D. A spring E



is inserted between the arm B and the spring balance D, and a dashpot F is mounted between the frame of the machine and the lower end of the spring balance. The dashpot serves to damp out rapid fluctuations of the pull transmitted by the arm B to the balance. Under working conditions any high-frequency vibrations of a more or less severe character are transmitted through the carcase and the arm B to the weights C, the inertia of which tends to minimise though not to eliminate the effect of the vibrations, and such effect as still remains is absorbed by the spring E and the dashpot F. In this way, a steady force is applied to the spring balance D and vibration of its pointer is avoided. Another dashpot G is affixed to the carcase. (*Accepted December 27, 1940.*)